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Photo on the cover:

Haj Terminal, King Abdul Aziz International Airport, Saudi Arabia. The terminal was designed by a U.S. firm to accommodate the more than 2 million Muslim pilgrims who annually travel to Mecca, located near Jeddah. (Photo credit: Aramco World Magazine)

Technology Transfer to the Middle East

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Foreword

This assessment was undertaken in response to requests of the House Committee on Science and Technology and the Senate Committee on Banking, Housing, and Urban Affairs to examine technology trade and transfer to developing countries in the Middle East. In addition, the Subcommittee on Energy, Nuclear Nonproliferation, and Governmental Processes of the Senate Committee on Governmental Affairs requested that the assessment examine transfers of nuclear technology.

This report clarifies the policy issues surrounding technology transfer to developing countries, by highlighting tradeoffs among various commercial, political, and development assistance policy goals, and by suggesting options for more consistent policies affecting technology transfer to developing countries. It follows earlier OTA work dealing with East-West technology transfer, including assessments of *East-West Technology Trade* and *Technology and Soviet Energy Availability*.

The study focuses on a region of great strategic importance, one where significant development efforts during the past decade have involved the introduction of technology from the United States and other supplier countries. It examines in detail competition among suppliers of technology, and problems the recipients face in effectively utilizing advanced civilian technologies in five sectors: petrochemical production, telecommunications systems, commercial aircraft support systems, medical services, and nuclear power. The policy perspectives of the recipient as well as other supplier countries and evaluated. The report identifies U.S. policy options in light of an evaluation of future prospects for Middle East technology trade.

OTA is grateful for the assistance of its distinguished project advisory panel chaired by George Bugliarello, and for the assistance and advice of numerous Middle Eastern policymakers, agencies of the U.S. Government, and individuals from academia and industry. It should be understood, however, that OTA assumes full responsibility for the report, which does not necessarily represent the views of individual members of the advisory panel.

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CHAPTER 1

Summary and Findings

INTRODUCTION

During the 1970's, the Middle East was the world's fastest growing market for engineering products, construction, and technical services. Rising oil revenues supplied the oil-producing nations in particular with the financial resources needed to purchase these imports. At no other time in recent history has a group of developing nations attempted so quickly and dramatically to transform their economies and societies as did the Islamic nations of the Middle East during this period. The experiences of these nations, which have been in a unique position to import advanced technologies from abroad, elucidate the promise and problems of technology transfer to developing nations.

U. S. firms and organizations have been major suppliers of engineering products and technical services to the Middle East, and this raises important issues for U.S. policy. These include questions concerning the competitive positions of U.S. firms in developing country markets, the long-term effects of technology transfers on the growth of export industries abroad, the effectiveness of U.S. Government-supported assistance programs involving technology transfers, and the military-strategic implications of advanced civilian transfers. The U.S. Government has no coherent policy governing technology transfer to developing nations, and there has been no systematic study of the policy implications of civilian technology transfer to the Middle East. The Office of Technology Assessment's (OTA) research was designed to clarify U.S. policy issues germane to civilian technology transfers to Islamic countries in the Middle East.*

Recipient and supplier nations alike have critical interests at stake in technology transfer. As a process that enhances the recipient's capacity to produce goods and services, technology transfer is a two-way interaction. For developing countries, successful technology transfers promise economic growth, improved living conditions, manpower development, and even enhanced national prestige and influence. However, technology transfers that fail or have unintended consequences may pose economic and political problems. From the perspective of supplier nations, technology transfers may help win friends, cement political alliances, increase exports, or alternatively lead to resentment and conflicts of interest. The promises of success and problems of failure are particularly apparent when new and complex technologies are introduced into developing nations that have limited scientific and technological infrastructures.

This study, undertaken at the request of the House Committee on Science and Technology and the Senate Committee on Banking, Housing, and Urban Affairs, examines the process of technology transfer to the Middle East (focusing particularly on competition among suppliers and absorption of technology by recipients) in order to identify policy issues for the United States. The Subcommittee on Energy, Nuclear Nonproliferation, and Governmental Processes of the Senate Committee on Governmental Affairs presented a supporting request that the study deal with transfers of nuclear technology to the Middle East.

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*The research focuses on six Middle Eastern nations: Algeria, Egypt, Iran, Iraq, Kuwait, and Saudi Arabia. These countries were selected because they have imported comparatively large volumes of equipment and technical services, because they have varied financial resources and labor forces to support technology transfer, and because they have different approaches to foreign policy and industrial development. Because Israel has attained a much higher level of technological development, it is not included as a major focus of study.

The term "Islamic countries" is used here simply to indicate that sizable proportions of the populations of these and some other Middle Eastern countries are Muslims, or followers of Islam. As discussed in ch. 3, however, there are many groups in these countries and the role of Islam in politics, economics, and social affairs varies widely.

The study examines technology transfers required for the establishment of several complex civilian production and service systems: petrochemical and nuclear power production facilities, telecommunications systems, commercial airline support services, and medical services. These types of technology transfers were selected because they are associated with large volumes of trade in equipment and technical services, because of the challenges recipients face in fully utilizing them, and because in recent years U.S. policies have restricted exports of advanced technologies for political and military reasons. This study addresses the following questions concerning advanced technology transfers:

- How extensive have transfers of advanced technologies been to the Middle East during the last decade, and what factors affect international technology trade?
- What factors inhibit or enhance the ability of recipients to utilize or absorb advanced technologies, and do the experiences of various nations differ?
- How effectively have U.S. firms and organizations transferred technology, and how well have they competed with those organizations from other supplier nations?
- What are the prospects for technology trade with the Middle East during the next decade, and what policy options are available to the United States?

Many U.S. policies affect technology transfer to developing nations in the Middle East, although these policies were not formulated with that goal. Technology transfer is often an underlying issue in discussions of development assistance, commercial, and political-strategic policies. Public policy debates, however, rarely center on civilian technology transfer. This study addresses the issue of whether the United States should develop more consistent policies regarding technology transfer.

PRINCIPAL FINDINGS

TECHNOLOGY TRANSFER AND TRADE DURING THE PAST DECADE

During the past decade, Middle Eastern countries have rapidly expanded their imports of advanced civilian equipment and technologies. The major suppliers have been the United States, Japan, and the West European countries. Total exports from industrial countries to 15 Islamic countries in the Middle East rose from $5.5 billion in 1970 to about $100 billion in 1982, an eightfold increase in constant dollars. Engineering products—machinery, equipment, and instruments—accounted for about half of these exports. Technical and managerial services have been increasingly important exports.

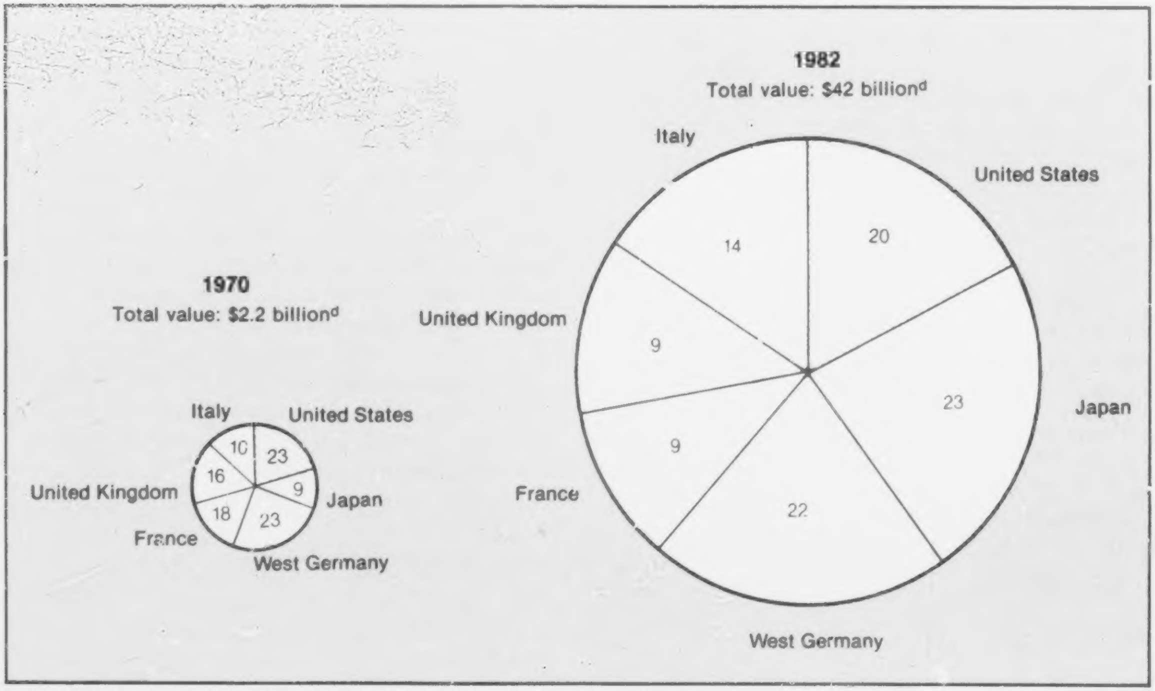
The Middle East is a very competitive marketplace, and suppliers have specialized in exports of certain types. U.S. firms have been major suppliers of machinery and equipment, particularly nonelectrical machinery and aircraft. Like the United States, West Germany and Japan have been major suppliers of machinery and equipment, but Japanese firms have been prominent in exports of basic manufactures such as consumer electronics and dominate in exports of road vehicles. In contrast, French firms have been particularly prominent in public works projects. **U.S. firms appear to have had a comparative advantage in the technical services area, including management of large projects and provision of technical support.** For newly industrializing countries such as South Korea, the Middle East is a key market for construction services. Soviet bloc countries have been much less prominent in commercial technology trade, but some of them have expanded sales in certain market niches such as medical services.

In 1982, the market share of U.S. firms remained approximately the same as it had been in 1970, 20 percent of machinery and equipment imports to the Middle East (see fig. 1). In contrast, Japanese firms increased their market share during the same period from 9 to 23 percent, while France's market share fell from 18 to 9 percent. U.S. economic interactions with the region have, furthermore, been strongly concentrated in trade with a small number of nations. Exports to Saudi Arabia and Egypt accounted for more than two-thirds of U.S. exports to the region in 1982.

Although Middle East technology trade has increased rapidly, OTA's research indicates that technology transfers have been limited. For the purpose of this study, technology transfer is a process involving a supplier and recipient whereby the recipient attains, as a result, an improved capability to operate an industrial production facility or service system. Technology trade, which includes international sales of industrial rights, equipment, technical services and training, and plans and documents, is only one part of technology transfer. Technology utilization or absorption by the recipient is a critical part of technology transfer. The extent of absorption depends on the type of capability developed by indigenous personnel in a particular firm or industrial sector—to operate and maintain equipment or, at higher levels, to modify the technology or design and produce new products. **OTA's research shows that technology is much more easily traded internationally than it is absorbed by recipients in developing countries.**

In the Middle East a number of factors constrain technology absorption. They all relate to the considerable technological distance that

Figure 1.—Supplier Shares of Six Industrial Countries[a] in Machinery and Equipment Exports[b] to the Middle East,[c] 1970 and 1982 (percent)



[a] Includes exports from the United States, Japan, West Germany, France, United Kingdom, and Italy.
[b] SITC commodity code 7.
[c] Includes imports to the following Middle East countries: Saudi Arabia, Iran, Algeria, Egypt, Iraq, Kuwait, United Arab Emirates, Syria, Lebanon, Jordan, Qatar, Oman, Yemen, South Yemen.
[d] In current dollars.

SOURCE: Office of Technology Assessment (based on table 28), and United Nations, *Trade With Industrial Countries, Supplement to World Trade Annual.*

must be bridged between the suppliers and the recipients. Chief among them is a disparity between human and financial resources. Countries such as Saudi Arabia and Kuwait, despite their capital resources, are constrained by shortages of technical and managerial personnel. In contrast, Egypt is the Middle Eastern country with the most extensive technological infrastructure, but many Egyptian engineers and teachers have gone abroad to find work. In addition, the Islamic countries of the Middle East are challenged to use foreign technologies and personnel in meeting development goals without creating irreconcilable conflicts with traditions and among groups in their societies.

TECHNOLOGY TRANSFER: COMPETITION AMONG SUPPLIERS AND TECHNOLOGY ABSORPTION

OTA's analysis of competition among suppliers for sales of advanced technologies indicates that a broad array of factors has influenced contract awards. In addition to price, the willingness of firms to provide state-of-the-art technologies, after-the-sale service, and training, as well as marketing strategies have been particularly important. While they have not determined overall patterns of technology trade, supplier government policies involving export financing, export controls, and representation of business have also been important factors in some cases.

To assess the extent of technology absorption, OTA's research focused on the technology-using firms and industrial sectors. The experiences of suppliers and recipients in various types of technology transfers were found to differ widely.

Petrochemical Production

Middle Eastern countries such as Saudi Arabia are currently expanding their petrochemical production facilities so that by the 1990's they will be producing approximately 4 percent of all major commodity petrochemicals manufactured worldwide, and their exports in these products will account for 20 percent of worldwide trade. Petrochemical technology transfers contribute to the growth of an important Middle Eastern export industry.

Middle Eastern countries building petrochemical industries (Saudi Arabia, Kuwait, Qatar, Algeria, Bahrain) have financed these capital-intensive projects themselves. However, they remain dependent on foreign technical assistance, even though the technology has become fairly standardized. U.S. firms are currently playing major roles as joint venture partners, licensors of technology, and contractors—particularly in Saudi Arabia, where joint ventures have been promoted. The quality of technology offered has been a major consideration for Middle Eastern countries in their awards of contracts to foreign firms. Kuwait, alone, has attempted to obtain petrochemical technology extensively through purchases of equity ownership in foreign firms.

Petrochemical technology is transferred to Middle Eastern countries in packages. This type of technology transfer allows recipients to operate the facilities efficiently by relying extensively on expatriate managers and technicians. **Over the long run, maintenance of the facilities and development of a skilled manpower base will be key issues for Middle Eastern petrochemical firms. Nevertheless, Middle Eastern nations will become world-scale producers in the 1990's.** Certain aspects of petrochemical production, such as comparatively low manpower requirements, capital intensity, and feedstock requirements, make it particularly well-suited to development in the countries bordering the Persian Gulf.

During the late 1980's, additions to petrochemical production capacity in the Middle East, Canada, Mexico, and Southeast Asia will have significant effects on global petrochemical product trade. Firms in western Canada and Mexico are more likely to make significant inroads in U.S. petrochemical markets than Middle Eastern manufacturers. While the United States will probably become a net importer of ethylene glycol and methanol by 1990, the U.S. petrochemical industry can remain strong, if production of specialty (and second-tier) chemicals becomes relatively more important. The impacts of these changes on employment in the United States should be minimal, since U.S. firms will continue to supply a large domestic market.

Petrochemical technology transfers to the Middle East therefore portend problems of structural adjustment for the industrialized countries, which will be particularly acute for Japan and Western Europe. It is unlikely that even a decline in the price of crude oil to as low as $25 per barrel would have a significant effect on the growth of the Middle Eastern petrochemical industry. A major problem involves the possible growth of protectionist barriers in Western Europe, which could be stimulated if Middle Eastern manufacturers sharply reduce prices to gain market shares. **If U.S. manufacturers emphasize production of specialty and second-tier chemicals, improve efficiency of operations and invest in research and development (R&D), they should be in a position to adjust to these anticipated changes in world markets.**

Telecommunications Systems

Telecommunications systems are important components of the national infrastructure needed for the growth of other industries and services. Technology absorption has been enhanced by the high priority placed on the development of this sector by Middle Eastern governments, by rapidly growing demand for services, by opportunities for regional cooperation, and by local production of equipment in Algeria and Egypt. On the other hand, inconsistent policies, shortages of indigenous technical workers in Saudi Arabia and Kuwait, and, in Egypt, inadequate incentives for technical personnel working primarily in government-owned telecommunications networks have limited absorption.

Competition among suppliers has been intense. Japanese firms have gained market share in telecommunications exports. Exports from the United States have been primarily in advanced technology subsectors, such as satellite communications, and they have been strongly concentrated in Saudi Arabia and prerevolutionary Iran. Since the major suppliers are now on a technological par in telecommunications, other factors have influenced contract awards. These include the ability of suppliers to provide comprehensive financing, as well as their reputation as reliable suppliers, their commitment to after-the-sale support, and the involvement of a firm at an early stage of a project when initial equipment selections are made. **Although U.S. firms maintain a reputation for technical capability, the ability of firms from Western Europe and Japan to put together comprehensive financing packages, sometimes including associated business deals, has been an advantage for them in some instances.** U.S. Government financing, however, has supported telecommunications technology transfers to Egypt and Algeria.

Commercial Aircraft Support Services

Compared to other types of technology transfers examined by OTA, the most extensive technology absorption has been in the area of commercial aircraft support services. The operating statistics of these airlines (including safety) indicate that they are on a par with major international airlines. **The comparative success of recipients in using these technologies can be ascribed to a number of factors, including well-defined standards of training and performance and relatively long experience.** Nevertheless, some of these airlines will depend on foreign technicians (for engine maintenance) for the foreseeable future. This is not because of a lack of ability on the part of indigenous workers, but rather due to a shortage of local technical workers willing to perform these tasks in Saudi Arabia and Kuwait.

U.S. firms are acknowledged leaders in avionics and aircraft engines, and have been leaders in airport management, but other suppliers are increasingly capable of providing similar equipment. U.S. aircraft sales in the region, important to sales of auxiliary equipment and services, have been negatively affected by U.S. export controls. Middle Eastern governments have in some cases sought to diversify suppliers for political reasons, such as dissatisfaction with U.S. policy positions.

Medical Services

During the last 10 years, Middle Eastern governments have strongly emphasized health care by increasing budgetary allocations to that sector. Of all the technology transfers examined by OTA, those in medical services are most likely to affect directly the longevity and quality of life of the average citizen in the Middle East. In addition, U.S. policymakers have a special interest in technology transfers in medical services—not only because medical equipment and services are important exports, but also because health care has been a priority in U.S. assistance programs.

Saudi Arabia is the largest Middle Eastern market for medical equipment and hospital management services. U.S. firms produce high-quality and reliable equipment, and they provided 18 percent of the medical equipment imported by Middle Eastern nations in 1980. U.S. firms have also been particularly prominent in the field of hospital management, providing evidence of their strong role in curative medicine. However, U.S. firms are not known for after-the-sale service. OTA's research indicates that such service has become a critical consideration for Middle Eastern buyers of medical equipment.

In contrast, U.S. assistance programs carried out by the Agency for International Development (AID) have focused on preventive health care, particularly in rural areas of lower-income countries, such as Egypt. Other supplier countries such as Sweden, Japan, Taiwan, and Belgium have aggressively promoted exports through bilateral health care agreements.

A major obstacle to medical technology transfer to the Middle East has been a lack of appropriately trained local medical personnel and experienced managers. Kuwait and Saudi Arabia possess the most sophisticated medical facilities, but their indigenous technical manpower bases are much more limited than those of Egypt and Algeria. Despite the commitment of Kuwait and Saudi Arabia to training and employing indigenous populations, cultural and other factors have inhibited recruitment of nationals into medical services. Foreign expatriates will be required to staff their medical facilities well into the 21st century. On the other hand, Egypt—a nation that exports medical personnel to other Arab nations—is challenged to improve the quality of personnel and management and integration of Egypt's varied health care facilities, public and private.

In the past decade, U.S. firms have been independently involved primarily in large hospital development projects in the region. **In the future, the most pressing need will continue to be in the area of preventive and less-sophisticated health care.** While opportunities for hospital management will continue in Saudi Arabia, demand for these services may grow less rapidly. Recipients will attempt to establish joint ventures with foreign suppliers in order to obtain specialized services such as training of indigenous personnel. The market share of U.S. firms in medical equipment may shrink unless improvements are made in U.S. after-the-sale service and maintenance. AID health projects have generally contributed to improvements in Egyptian health indicators, but programs providing specialized training and retraining of medical personnel may be particularly important in the future.

Nuclear Power Generation

Nuclear power is in its infancy in the Islamic countries of the Middle East: there is no commercial nuclear power reactor in operation in the region today nor is there likely to be one in operation before the 1990's. However, decisions made now concerning nuclear technology transfers may significantly affect the economic, military, and political future of the region. Middle Eastern approaches to nuclear technology transfers differ widely: Iran had the most ambitious commercial nuclear power program prior to the revolution; Egypt has the strongest rationale for commercial nuclear power, but financing remains a major constraint; Libya has most clearly expressed its intentions to develop nuclear weapons. Most of the nations of the region have not yet committed themselves to nuclear programs.

Despite the very high growth in demand for electricity, a number of factors reduce the attractiveness of commercial nuclear power for most Middle Eastern countries. The most important is the availability of hydrocarbon resources. In addition, only Egypt, Iran, Kuwait, and Saudi Arabia will possess the interconnected grid and electricity generation capacity needed to accommodate a 900-megawatt (MW) commercial reactor by 1990.* However, if small reactors (under 600 MW capacity) become available, other Middle Eastern nations could be buyers. OTA's analysis indicates that nuclear desalination, a potentially useful application, will be attractive only to nations where nuclear power generation is economically feasible. **Even for Egypt, the country with the strongest rationale for nuclear power, progress in nuclear power development has been slow. Egypt's program will progress only with subsidized financing from abroad.**

Transfers of nuclear technology are important not only because of their potential in electricity generation, but also because transfers of certain types raise questions of nuclear weapons proliferation. OTA's analysis indicates that no Islamic Middle Eastern country will be capable of acquiring a nuclear device on a wholly **indigenous** basis within this decade, and most would find it impossible to do so before the turn of the century. The major constraints on the proliferation of nuclear weapons have been the weak technical capabilities of these countries and the reluctance of suppliers to sell unsafeguarded enrichment and reprocessing facilities.

The most likely path to nuclear weapons production is through the use of small-scale research reactors in conjunction with laboratory-scale enrichment or reprocessing facilities over a long period of time, allowing for production of very small amounts of weapons-grade materials. Middle Eastern countries will build their latent nuclear weapons production capabilities gradually, unless one of the countries in the region demonstrates its capability to produce nuclear weapons and thereby stimulates other nations to follow suit, or unless supplier nations significantly relax export regulations and safeguards requirements.

Prospects for nuclear weapons proliferation in the Middle East are likely to increase during the next decade because new supplier states, such as Argentina, Brazil, and India, that are not parties to the Nonproliferation Treaty may be willing to sell sensitive facilities and also because Middle Eastern countries will gradually improve their indigenous capabilities. Policy options available to the United States are limited, but they include bilateral nuclear cooperation agreements with countries developing expanded nuclear power for peaceful purposes, financing of nuclear exports to countries accepting stringent safeguards, or assistance to developing nations in assessing various energy options. Stronger consensus among suppliers to limit exports of highly enriched uranium and laboratory-scale sensitive facilities could contribute significantly to nonproliferation goals.

Impacts of Technology Transfer to the Middle East

The ability of recipient countries to utilize imported technologies effectively depends not only on the sophistication of the equipment, but also on the capabilities of the indigenous work force. OTA's research indicates that **experiences with technology absorption differ widely across countries and technology sectors. Generally speaking, recipients have developed an independent capability to operate and maintain facilities, but not to modify equipment or significantly adapt technologies imported from abroad.**

Not surprisingly, technology absorption has been most limited when new and extemely complex technologies were introduced. Transfer of nuclear technology represents the extreme case—not only is experience limited and technologies complex, but most of these countries have not built an internal consensus favoring nuclear power development. **Technology absorption has been comparatively extensive when transfers contribute directly to production of locally used goods and services, as indicated by successful transfer of commercial airline support technologies.** In cases where industries are not forced to compete directly with foreign firms, recipients have more leeway to introduce training and local employment requirements, though this is often costly.

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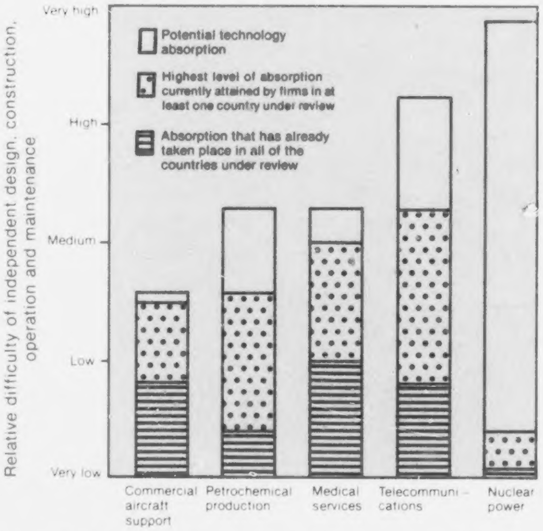
*These countries will probably be able to install a 900-MW reactor that does not generate more than 10 percent of total installed interconnected electrical grid.

In contrast, technology absorption in the petrochemical sector will be limited for some years to come, mostly because this industry must compete directly with industry leaders in world markets. Middle Eastern petrochemical producers are relying heavily on expatriate personnel and the acquisition of technology in the form of packages, while gradually increasing indigenous personnel. **Technology transfers in petrochemicals will benefit recipients through increased export revenues, despite the near-term limitation of technology absorption. Figure 2 illustrates a range of experiences with technology absorption in the five sectors under study.**

Middle East countries face varied problems in importing and using foreign technologies. A key question is how quickly to implement programs aimed at expanding the indigenous technical work force. Rapid expansion can be very costly in the short run. However, reliance on expatriate labor may limit long-term absorption, particularly if it precludes development of domestic technological capability. **For both the oil-rich and oil-poor countries, inadequate supplies of technical manpower present a critical constraint on technology absorption.** Egypt's problem is to put to better use and upgrade the capabilities of its comparatively well-developed technical manpower base; Saudi Arabia and Kuwait must build from much smaller technical manpower bases.

Figure 2.—Summary of Findings: Technology Absorption in the Middle East, 1984



Note: Height of bar indicates relative difficulty of tasks required to design, construct, operate and maintain facilities independently.
Potential technology absorption refers to the level required to operate and maintain facilities independently on a par with similar facilities in industrial countries.
Evaluation of the current extent of technology absorption is based on an assessment of the sophistication of technologies and the efficiency of operations, as well as the capability of indigenous personnel to use them.

SOURCE: Office of Technology Assessment.

The technology transfers examined by OTA have certainly contributed to the growth of Middle Eastern economies and to the export revenues of supplier firms. From a commercial perspective these technology transfers have generally been mutually beneficial. For each type of technology transfer, OTA identified positive and negative effects (political, social, economic) on recipients and suppliers. The choices made by political and technical leaders in the recipient countries about selection and use of imported technologies lead to fundamental economic, social and political changes in their countries. In some cases, certain groups in society may benefit disproportionately from advanced technology transfers, leading to resentment and political opposition on the part of others. In other cases, the life of the average citizen may be greatly improved. Choices made by policymakers determine whether the technology transfers fit with resource endowments, meet the needs of the local population, or build indigenous capabilities.

Technology transfers involve ongoing relationships between recipients and suppliers that include both potential risks and benefits. It is beyond the capacity of governments to develop policies that eliminate these risks or anticipate the potential effects of all commercial technology transfers.

POLICIES AFFECTING TECHNOLOGY TRANSFER

No nation has developed a systematic policy governing international technology transfer, but many recipient and supplier nations have developed policies to promote and regulate technology transfer.

RECIPIENT COUNTRY POLICIES

Policymakers in the Middle East are trying to transform their economies rapidly, largely through the introduction of foreign technologies. Yet they are attempting to do so while avoiding excessive dependence on foreign suppliers; maintaining their political legitimacy and influence over domestic economic, social, and political developments; and preserving indigenous cultures, traditions, and values. **Despite these common challenges, there is considerable variation in the policies of these countries.**

These countries do not have comprehensive technology transfer policies, but all are attempting to improve their capacities for selecting and using foreign technologies, carried out primarily by strong government firms and institutions. Each has developed an implicit strategy for dealing with technology transfer choices in conjunction with development planning, and some have already experimented with and modified their approaches in the last decade. All face choices concerning the nature and pace of economic development, promotion of private enterprise, regulation of foreign businesses, choice of suppliers, financing, education and manpower policies, and administrative reform.

Saudi Arabia and Kuwait emphasize capital-intensive technology transfers, while Algerian leaders, dissatisfied with the earlier emphasis on heavy industrialization, have come to stress labor-intensive technology transfers. While Iraq has attempted to limit involvement by foreigners, Egypt and Saudi Arabia have encouraged joint ventures.

These countries face different immediate problems. For the labor-short Gulf States, Saudi Arabia and Kuwait, one challenge is to train indigenous workers to use foreign technologies effectively. In both countries, shortages of technical manpower may be allayed over the short term through a reliance on foreign labor while the local population is gradually trained. However, technology absorption may be limited in the long term unless the local population is attracted to enter technical jobs by incentives introduced by the governments.

For those countries with larger populations but limited financial resources, such as Egypt and Algeria, issues of promoting private sector firms, administrative reform and the financing of technology transfer are paramount. Egypt, a country rich in human resources, is challenged to eliminate the economic disincentives such as subsidies and occupational redundancy that grew with a large bureaucracy and to introduce efficiency into public sector firms. Egyptian leaders must chart a delicate course, however, because economic reforms may give rise to conflicts among various groups. Algeria as well as Egypt must deal with the issues of administrative reform and migration of workers abroad.

Both Iran and Iraq had comparatively well-developed infrastructural and industrial bases prior to the current Iran-Iraq War. A key issue for both is how to compensate for the diminution in resources available for civilian technology transfers resulting from their preoccupation with the war effort. In Iraq, lack of financing has already jeopardized technology transfer plans in certain sectors. The regime in Iran, though outwardly hostile to Western influences, has in recent years expanded trade with West European and Japanese suppliers. For both these countries, however, the war is the key factor affecting prospects for civilian technology transfer.

These countries have attempted to diversify their reliance on outside suppliers of technology for both political and economic reasons. Most of them also look favorably on proposals for regional economic and technical cooperation, though progress has been limited by political differences. The persistence of regional conflicts undoubtedly remains a major constraint on effective commercial technology transfer.

POLICIES OF OTHER SUPPLIER COUNTRIES

Apart from the United States, the most important countries supplying advanced technologies to the Middle East are those in Western Europe, and Japan. **In comparison to the United States, Japan and West European countries emphasize economic interests more in their foreign policies, and their policies have generally supported technology trade with the Middle East.** While these nations have approached technology transfer quite differently, the absence of controls on technology exports—as well as their readiness to combine development assistance and commercial promotion programs and the willingness of government officials to take a leading role in economic diplomacy—have supported expanded technology trade with the region. Supplier-government export financing has influenced competition in transfers of commercial aircraft, telecommunications, and nuclear power technologies, to countries such as Egypt and Algeria, but official export programs have not determined general patterns of technology trade. More importantly, government and business are normally on the same side—supporting technology trade.

Soviet bloc nations, in contrast, are much less important as suppliers of advanced civilian technology to the Middle East, and therefore do not figure prominently as competitors in the technology transfer sectors examined by OTA. For the Soviet Union, military assistance has been the most important channel for interactions with Middle Eastern countries, but commercial interests have become more salient in recent years. Some East European countries have expanded exports to the Middle East, but they provide only a small share of total imports to the region, and these have been concentrated in a few sectors such as heavy machinery. **Despite the comparatively small role that Soviet bloc nations play in commercial technology trade with the region, some Middle Eastern countries have been recipients of Soviet military assistance, and the Middle East has been the largest non-Communist developing country export market for Soviet bloc nations.**

Supplier governments play important roles by setting the context for technology trade through their foreign policies. **Historical and political factors strongly influence technology trade with Middle Eastern countries.** French exports flow primarily to Egypt and Algeria (a former colony), while British exports go to Oman, the United Arab Emirates (UAE), and Qatar—all under British rule in years past. Soviet bloc exports are concentrated in Iraq, Iran, Syria, and Algeria. In contrast, Japan's technology exports are less concentrated and reflect that country's weak historical ties to particular nations in the region.

The United Kingdom and the Soviet Union, which in addition to the United States have played important political and diplomatic roles in the Middle East, have placed less stress on promotion of commercial technology trade than have nations such as Japan, West Germany, Hungary, and Romania. France, in contrast, has attempted to combine a high-profile diplomatic role with state-led trade promotion. **In the past decade, Japan, a nation that has not assumed a leading political role in the Middle East, expanded its market presence in countries with differing positions on political issues.** Government policies, particularly overall foreign policies concerning the Arab-Israeli dispute, remain important influences on technology trade. In some cases, the absence of political constraints on trade set by supplier governments has been an asset to foreign exporters in establishing diverse trading relations in the Middle East.

U.S. POLICIES

U.S. policies affecting technology transfer have been more restrictive than those of other Western supplier nations. During the past decade, U.S. trade with countries of the Islamic Middle East has grown rapidly, despite the fact that official policies have been characterized by an unusual tension between economic and political goals. This tension has precluded the formulation of a coherent policy governing technology transfer.

U.S. interactions are strongly concentrated in a few Middle Eastern countries: in commercial trade, Saudi Arabia and Egypt are the major trading partners of the United States; in economic and military assistance Egypt (and Israel) have been the most important Middle East recipients. U.S. technology trade with the Middle East thus reflects political alliances.

During the last 30 years, U.S. foreign policy has reflected four themes: ensuring the security of Israel, ensuring oil supplies to the West, limiting Soviet expansion in the region, and promoting the economic and social development of Middle Eastern countries. **Official U.S. policies have, however, placed increasing stress on military and security issues rather than on commercial interests during the past 10 years.**

U.S. Government programs designed to promote the representation of U.S. business abroad, including both high-level trade missions and routine representation by the Foreign Commercial Service, have been comparatively weak. Only a few programs are designed, even in part, to promote technology transfer. In addition, there has been continuing controversy concerning official export financing, particularly mixed credits, which combine commercial and concessional financing. U.S. export financing programs are not as broad in scope as those offered by some other Western supplier nations. On the other hand, such Government supports have only infrequently been determining factors in competition for contracts in Middle Eastern markets. Finally, the United States has established few bilateral trade or investment treaties with any nations in the region except Egypt.

U.S. development assistance policies are particularly important for lower-income Middle Eastern countries, especially Egypt. **AID administers a vast number of programs, but few are designed with the goal of promoting technology transfer in the industrial and service sectors examined by OTA.** Congress has emphasized the importance of science and technology programs, but in Egypt these programs have not been guided by a coherent strategy and only a small number are directed toward assisting industrial end-users of technology. The United States has few Government-supported technical assistance efforts in high-income, developing nations in the Middle East, the most prominent being those supported by the U.S.-Saudi Joint Commission.

U.S. policies affecting technology transfer are distinguished from those of other Western supplier nations by the recent expansion of controls on exports. These controls heighten the political dimension of U.S. technology trade with the Middle East. **There is general agreement among U.S. experts that national security and nuclear nonproliferation controls have been effective in limiting exports of military equipment and slowing nuclear weapons proliferation. There is less agreement concerning foreign policy controls, antiboycott regulations, and other types of controls.** Proponents of controls argue that the United States can use them to take a stand in support of political principles and that the economic loss resulting is minimal or worth the cost. Opponents argue that foreign policy and other "political" controls have rarely achieved their designated goals, that the economic effects have been significant, and that they earn the United States a reputation as an unreliable supplier. **It is impossible to measure precisely the impacts of various types of controls on trade, but taken together these controls have been a liability to U.S. exporters and have served to inhibit trade.** OTA's research did not uncover cases where the use of foreign policy controls clearly resulted in the achievement of desired political results.

FUTURE PROSPECTS

PROSPECTS FOR U.S. TECHNOLOGY TRADE WITH THE MIDDLE EAST

For the Islamic countries of the Middle East, the decade ahead will be one of slower economic growth than the 1970's. The major reason is that oil revenues are expected to grow at a slower rate (5 percent per annum or less in real terms), reducing the prospects for government spending, which has been the major driving force behind technology trade. For this and other reasons, imports of machinery and equipment can be expected to grow at roughly the same rate as oil revenues, in contrast to the 19 percent annual real growth in the 1970-82 period. **The Middle East will remain an important market for technology trade in the years ahead, but the explosive growth of years past will probably not be repeated.**

OTA's analysis includes two scenarios for the future, involving high and low U.S. export shares to the Middle East. While the high export share is theoretically possible, OTA concludes that it is less plausible. **In light of anticipated slower growth in the volume of overall exports to the Islamic Middle East, it may well be that the U.S. export share will decline.** A number of factors, including a shift toward smaller projects in the Middle East and the desire of Middle Eastern countries to diversify suppliers, and the course of the Iran-Iraq War will influence technology trade. U.S.

Photo credit: Aramco World Magazine

In less than a decade backyard generators have been replaced by power grids, like the one shown here carrying electricity to the new industrial city of Jubail in Saudi Arabia firms, no longer enjoying an overwhelming technological edge over competitors in many sectors, must adjust to changing Middle East technology requirements in order to maintain their position.

OPTIONS FOR U.S. POLICIES AFFECTING TECHNOLOGY TRANSFER

In view of the persisting tension among various policies (commercial, development assistance, military-strategic) affecting technology transfer, it is not surprising that a coherent technology transfer policy has not been established. Policymakers may wish to alter substantially the scope and nature of commercial technology transfers to the Middle East by developing a more consistent policy. **In order to do so, however, a new understanding of the role of technology transfer in U.S. foreign policy would have to be established.** Three general perspectives are outlined below.

Perspective 1: Selective Use of Technology to Promote Political Interests

This approach would make technology trade the servant of U.S. foreign policy toward the Middle East. The U.S. Government would not only extend export controls to impose sanctions on countries whose policies run counter to those of the United States, but would also selectively provide advanced technologies (e.g., dual-use items) to countries associated with U.S. political positions. Development assistance programs could be used as a vehicle for rewarding friendly nations.

This option has the advantage of placing major emphasis on U.S. foreign policy interests that are of central importance to policymakers. It capitalizes on denial and supply of technology to influence the behavior of recipient countries. In cases where other policy measures are inappropriate or unavailable, this approach would allow for systematic policies of denial. On a more positive note, the provision of advanced technologies to nations closely associated with U.S. positions could enhance their regional and global stature.

The approach, however, has serious drawbacks. Success would depend on accurate forecasts of the foreign policies of Middle Eastern countries. One danger would be that shifts in political alignments and regime changes could lead to sudden interruptions of technology transfers. Another problem is that if U.S. policymakers control items that are readily available from foreign suppliers, buyers probably will simply go elsewhere. This option would place considerable burden on the Government to monitor and regulate commercial trade and technology transfers, despite the fact that OTA's research indicates severe obstacles to anticipating the long-term effects of technology transfers.

In addition, this approach could be seriously impeded by disagreement concerning appropriate U.S. policies toward specific countries. Finally, it would rely strongly on the use of foreign policy controls, despite the fact that many observers question their effectiveness in achieving political goals. It would certainly politicize even more strongly U.S. technology trade and would run the risk of jeopardizing relations with nations not closely associated with U.S. positions, yet not strongly opposing them.

Perspective 2: Decouple Commercial Technology Trade From Political Interests

Policymakers may wish to reduce the linkage between politics and economics which has distinguished U.S. policies from those of other supplier nations. This approach is based on the assumption that technology trade should be promoted with all nations, regardless of their political positions, because it not only brings commercial gains to the United States but also serves as a foundation for friendly political relations. U.S. diplomatic efforts would proceed independently, while trade in nonmilitary items would be permitted with any nation in the region where U.S. firms judged the market opportunity worth the risk of investment or involvement. Foreign policy export controls would be eliminated, making U.S. policies more similar to those of Japan and West European countries.

One advantage would be to eliminate the tension that has existed between commercial and political interests; another would be to promote technology trade with Middle East countries. It would put U.S. firms on a more equal footing with their competitors, and possibly lead to the expansion of exports to nations not currently major U.S. trading partners in the region. In addition, it would place fewer demands on the Government to regulate trade than would the first option. This option could be expanded to include improved representation of business, but the major emphasis would be on decoupling trade from politics.

By eschewing the use of technology trade as a lever, this approach narrows the range of instruments available to policymakers. At the same time, it might increase the probability that U.S. firms could become targets of political opposition because of their expanded involvement in countries whose governments oppose U.S. political positions. Nor would such a policy guarantee the end of the selective technology trade characteristic of years past. OTA's research indicates that technology trade may remain strongly influenced by U.S. foreign policies: even if the disincentives for nonselective trade were eliminated and promotional policies enhanced, recipient governments might still wish to diversify suppliers for political reasons and U.S. firms might prefer to trade with countries friendly to the United States. However, ending foreign policy and other political constraints on technology trade would undoubtedly encourage wider and more flexible trading relations over time.

Perspective 3: Promote Civilian Technology Transfer

Both the technology leverage and decoupling perspectives are oriented more toward technology **trade** than its **transfer**. Policymakers may wish to facilitate expanded technology transfers from the United States, and more extensive absorption of technology by recipients in the Middle East, by establishing more explicit policies. This is based on the assumption that civilian technology transfers have been generally mutually beneficial, and the U.S. Government can do more to promote them. Underlying this perspective is the conviction that it is useless to try to control transfers of civilian technology, and a recognition that U.S. firms can best maintain their technological strength by fully participating in international technology exchange. While retaining national security and nonproliferation controls, this approach would employ other types of export controls only under extraordinary circumstances, such as the Iranian hostage crisis.

A variety of commercial and development assistance policy measures could be used to promote technology transfer. These include expanding assistance programs involving technology transfers in manufacturing and service sectors, upgrading the technical capabilities of the commercial representatives, expanding technical assistance and bilateral investment agreements, improving U.S. Government financing and insurance programs supporting technology transfers, as well as improving the ability of the Federal Government to record and anticipate trends in technical service trade. In light of the interrelationship of manpower problems among countries in the Middle East, U.S. Government-supported technical assistance efforts could include participants from a number of countries, including the higher-income nations. Coordination with private sector firms would be important to the success of all these efforts.

One problem is to coordinate the efforts of Government agencies currently involved in various aspects of these disparate programs. This implies increased allocation of resources, challenges in designing programs aimed to transfer technology, and in evaluating their success. In addition, disagreements might well arise over when "extraordinary circumstances" would justify use of controls on trade. On the other hand, this approach emphasizes the positive aspects of technology transfer. While these programs would probably not drastically affect technology trade with close political allies or with strong political opponents, they could open relations with nonaligned countries. This approach is unique in that it could also contribute significantly to regionwide development.

Each of the three policy perspectives outlined above involves a consistent strategy, emphasizing political and economic objectives in different ways. Although each may have its virtues in the abstract, a new consensus on the role of technology transfer in foreign policy would be required to implement fully any one of them.

Even if no consistent technology transfer policy is established, U.S. policymakers will continue to face a fundamental choice as they make decisions on a case-by-case basis: they can promote or discourage technology transfer. Civilian technology transfers to the Islamic countries of the Middle East appear to have been mutually beneficial in economic terms, and are highly valued by recipient countries. Therefore, U.S. policies—regardless of which goals are maximized—will remain important to Middle Eastern countries.

In the decade ahead, the Middle East will remain a market for U.S. equipment and technical services, and a region of great strategic importance. Instead of subordinating economics to politics, the challenge for U.S. policymakers is to balance these interests in a more consistent way. In the absence of such effort, the pattern of expanding controls and selective technology trade characteristic of years past is likely to continue. Technology transfers from the United States to countries in the Middle East are a major dimension of U.S. influence there. Despite the negative effects of some technology transfers, more often civilian technology transfers have supported mutually beneficial relations with countries of great strategic and economic importance to the West.

CHAPTER 2

Analyzing Technology Trade and Transfer: Conceptual Issues and Policy Choices

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CHAPTER 2

Analyzing Technology Trade and Transfer: Conceptual Issues and Policy Choices

INTRODUCTION

Technology transfer to the Middle East is a complex process that occurs primarily in the commercial marketplace through transactions between suppliers and recipients. In the Middle East, governments and public corporations are the primary recipients. On the supplier side, while governments influence civilian technology trade through various policies and assistance programs, the major participants are private U.S. firms. In Western Europe, Asia, and Soviet bloc nations, the suppliers are often public corporations.

Technology transfer is necessary for the achievement of widely differing goals, and its effects on recipient countries can vary considerably. For example, technology transfers can lead to improvements in agricultural yield (through introduction of irrigation technologies), better quality of life (through provision of medical services), foreign exchange revenues (through the establishment of manufacturing facilities that produce goods for export), or to the potential expansion of regional conflict (through the introduction of enrichment and reprocessing technologies which can be used to produce nuclear weapons). When technology transfer works, the recipient develops a greater capability to operate a production process or a service system, and the supplier accrues commercial and sometimes political gains. However, suppliers and recipients rightly worry about the potential negative consequences of technology transfers that fail to achieve anticipated results.

This report evaluates the benefits and costs of technology transfers to the Middle East from the perspective of the U.S. Government. Generally speaking, unless overarching foreign policy interests justify restrictions on technology transfer for military or strategic reasons, the major concern is that technology transfers involve fair exchanges in which U.S. firms and organizations are appropriately compensated, that the transfers be successful in improving the recipient's capability and thereby serve to reinforce mutually beneficial international relations, and that trade frictions with new recipient producers and with other supplier nations be avoided. In practice, however, U.S. policies affecting technology transfer to the Middle East have been distinguished by a tension between political and economic interests. Chapters 13 and 15 identify and assess the competing themes in U.S. policies affecting technology transfer.

Analysis of technology transfer poses some difficult questions: How is commercial technology transfer[1] distinguished from trade—and how extensive have technology transfers, in contrast to trade, been to the Middle East during the past decade? What factors affect the ability of recipients to use or "absorb" imported technology? What factors influence flows of technology between suppliers and recipients in the Middle East? What choices do recipients and suppliers face as they engage in technology transfer transactions? This chapter outlines an approach to analyzing these questions. Its primary focus is conceptual; it provides a framework for the analysis of technology trade and transfer in the chapters that follow.

Because of the absence of quantitative indicators which would allow us to measure technology transfer precisely, trade flows can be traced much more easily than the actual extent of technology transfer. This chapter explores economic and political factors influencing technology trade, the context in which technology transfer normally occurs. It identifies factors which affect technology transfer directly at the project or firm level, as well as broader effects. A central theme of the chapter is that there are significant constraints on technology transfer, despite the rapid growth and mutually beneficial effects of trade.

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[1] Technology transfer can take place illegally through theft of information, documents, or products embodying technology. This report, however, focuses on commercial technology transfers.

Technology transfer to the Middle East raises important foreign, commercial, and development assistance policy issues for the United States. The U.S. Government has a strong interest in the peaceful development of Middle Eastern nations, and Western technology can contribute to this process. This applies not only to the oil-rich countries of the region, but also to other important countries such as Egypt. Transfer of advanced civilian technologies is also important from a strategic perspective, since U.S. policies include restrictions on exports of advanced technologies (e.g., civilian aircraft), in order to achieve foreign policy goals, and technologies with military applications (e.g., some nuclear technologies) in order to reduce the proliferation of nuclear weapons. From a commercial perspective, the United States has an interest in promoting technology trade and in anticipating and avoiding trade frictions arising from the growth of Middle Eastern export industries and from unfair competition between suppliers. Technology transfers are, in turn, affected by and raise critical questions for commercial, assistance, and strategic policies of the United States.

Chapter 2 begins with a discussion of the meaning of technology transfer, which includes consideration of factors directly affecting the process and problems of measurement. Next, the chapter analyzes factors affecting international flows of technology to the Middle East, since technology trade (through various channels such as sales of products and equipment, turnkey plants, technical services, direct investment, licenses and patents) is the means through which technology transfers normally occur in the commercial marketplace. Finally, the chapter deals with the policy choices that recipients and suppliers face, explicitly or implicitly, as they interact in technology transfers.

TECHNOLOGY TRANSFER AND TRADE: MEANING AND MEASUREMENT

RELATIONSHIP BETWEEN TRANSFER AND TRADE IN TECHNOLOGY

Definitions of technology and technology transfer abound. Technology is the knowledge needed to design, create, or implement a production process or the services related to the process. Technology is the specific application of scientific and technical knowledge to the production of goods and services.[2]

As used in this study, technology transfer is a process involving at least two parties, whereby the recipient attains, as a result, an improved capability to design products or to operate a production facility or a service system. Technology transfer involves:

1. technology trade—the provision of technology by a supplier to a recipient through commercial transactions; and
2. technology absorption—the use of that technology by the recipient; e.g., in operating and maintaining a manuacturing facility.

Because technology transfer involves scientific and technical knowledge required for these specific operations, it differs from the general dissemination of scientific information. Most standardized technologies are rather far removed from science.

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[2] See "Technology Transfer: Definition and Measurement," in *Technology and East-West Trade* (Washington, D.C.: U.S. Congress, Office of Technology Assessment, OTA-ISC-101, November 1979), pp. 99-105.

For technology transfer to occur, a variety of transactions must take place, often simultaneously. These transactions include the sale of industrial rights, provision of training, technical and management services, designs, plans, and documents, as well as the supply of equipment needed to operate and maintain a complex industrial or service system. Transfer costs incurred by both parties range from trivial to very high. Normally, these transactions take place in the commercial marketplace, but government-supported economic assistance programs and government-to-government technical cooperation programs are also conduits.

A commercial transaction (e.g., the sale of a turnkey plant) indicates only that successful technology transfer might have taken place. The teaching and learning required for technology absorption generally take place over time and imply a two-way interaction. For technology transfer to occur between parties in industrialized and developing countries, it is necessary to bridge a considerable "technological distance," and this bridging usually takes place gradually[3]—particularly when the technology transferred results in the addition of completely new production capacity.

Technology transfer occurs through technology trade but should be distinguished from it. If the recipient merely purchases equipment but is unable to use it, technology trade has occurred, but no absorption has taken place; in such a case, only part of the process of technology transfer has been completed. As the recipient more fully absorbs the technology, the capability to operate and maintain it is developed. When technology is fully mastered or absorbed, the recipient is also able to design and produce new products, to adapt the technology. If the recipient depends completely on expatriate workers to operate and maintain the facility, technology absorption is limited. However, even in this case, the production capacity may be an asset to the recipient if revenues accrue from sales of products or services.

Technology transfer normally occurs in the context of a particular enterprise, project, or industrial sector. In order to determine the level of capability that has been developed (the extent of technology absorption), it is therefore necessary to examine the effects of technology transfer in the particular productive enterprise. Although numerous factors—e.g., national development plans, education, labor, investment and trade policies, the political and economic context, and policies of and relations with suppliers—importantly affect and are affected by various transfers, the effects in the productive enterprise or sector receiving the technology are the most important indicators of the extent of transfer.

ASSESSING TECHNOLOGY TRANSFER

Evaluations of the extent of technology transfer are based on judgments about the operational efficiency of the facilities, and the quality and skills of the work force in the particular firm, project, or sector. In addition, the "linkage effects," or the contribution of the transfer to other economic sectors or to the country's overall science and technology infrastructure, are also often taken into consideration. But policymakers in particular often evaluate the overall "success" (the net costs and benefits) taking a variety of other considerations into account.

Evaluating the Extent of Technology Transfer

Operational Criteria.—From an operational viewpoint, transfer occurs when the transfer and production costs and the quantity and quality of output are acceptable by relevant standards. Particularly for export industries, the relevant standards may be those of the most advanced producers in other parts of the world. These standards may include costs of production, foreign exchange earnings, and profits of the firms that are the industry leaders. For other types of operations, such as local service systems, the relevant standards may be those of newly industrializing nations. In developing countries, it is often difficult to assess the efficiency of operations: costs may be competitive if labor is cheap, even though efficiency is low by other measures.

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[3] For a discussion of characteristics of technology transfer between developed and developing nations, see Organization for Economic Cooperation and Development, *North/South Technology Transfer* (Paris: Organization for Economic Cooperation and Development, 1981), p. 24.

In cases of unsuccessful technology transfer, the operation may be abandoned before it goes onstream, or the output of the facility may be of such high cost and low quality that even domestic sales in a protected market are difficult. More specifically, inefficient operations may result from lack of proper maintenance of equipment, owing to improper procedures; inadequate skills and spare parts; and inclement surroundings. Judgments about operational efficiency must be based on knowledge of the technologies and production facilities involved, and comparisons to operations elsewhere.

Quality and Capabilities of the Work Force.—People are essential for technology transfer. Transfer involves technology absorption—learning by the work force of skills needed for effective operation and maintenance of interrelated technical, financial, marketing, and personnel functions of the enterprise. Normally, these capabilities are developed over time when the transfer involves the establishment of a new type of facility in a developing country. In such cases, expatriate workers may be needed at early stages.

The number of indigenous workers alone is an inadequate indicator of technology transfer: local workers may serve in name only to fill an employment requirement. It is more important to determine what positions indigenous people hold, what capability they possess to carry out their jobs, and whether there has been improvement in their capabilities over time. Recipients in developing nations often place special emphasis on technology absorption in their assessments of the extent of technology transfer.

Linkages to Other Sectors.—The extent of technology transfer can also be assessed in terms of the linkages that exist between the technology-receiving firms and other firms and organizations throughout the society. The movement of skilled workers from the original enterprise to other enterprises may be viewed as a means of diffusing technology transfer to other firms or sectors in the national economy. On the other hand, such movement may result in a loss of capability at the original enterprise. Regional manpower migration in the Middle East is a complex phenomenon, and the benefits and costs may be assessed from the perspectives of the firms, the industrial sectors, and the countries of origin and destination.

Technology transfers can also be evaluated in terms of the contribution they make to the development of a science and technology infrastructure in the recipient country. When research capabilities are expanded, when the numbers of trained scientists and engineers are increased in conjunction with the transfer, the technological capability of the nation may be improved. Development of institutions and centers for research and training is essential for deepening technology transfers in the long term.

Evaluating the Success of Technology Transfer

Evaluations of the overall success (the net costs and benefits) of a transfer depend on the broad policy goals and priorities of suppliers and recipients. Evaluation depends on the priority placed on various political, social, environmental, and economic goals, and on judgments about the past or potential impacts of transfers. As discussed in detail later in this chapter, suppliers and recipients alike weigh a number of factors in deciding whether to engage in technology transfers and in judging their success.

To expand the indigenous work force and to ensure fairness in technology transfer transactions, recipient governments introduce regulations. These may encompass ownership, control, local content, technology and output

Photo credit: Aramco World Magazine

Solar energy research in Saudi Arabia involves researchers from the University of Petroleum and Minerals

pricing, and the ability of the recipient to transfer to third parties. Broadly speaking, the aim is to ensure that transfer will result in a self-sustaining capability for technological development. What is desired over the long term is thus not only a maintenance and production capability, but also an indigenous technical capability to develop technology and a demonstration that particular projects contribute to achieving this goal.

Recipient governments and firms often select certain types of technologies because of other policy goals—in order to develop particular economic sectors or because of a preference for labor- or capital-saving technologies. Political considerations may importantly influence choices of technologies and evaluations of success or failure. Planners in developing countries may evaluate technology transfer as problematic if production costs are substantially higher than estimates, if production machinery designed to conserve energy and labor is installed in a labor- and energy-abundant but capital-poor economy, or if equipment designed for large-scale operations is installed in a small factory and operated at high cost. On the other hand, recipients may judge a project successful if they see it as adding to national prestige, regardless of efficiency of operations.

At the supplier firm level, criteria of success may be much narrower than a full operational criterion. When a turnkey plant has paid off the cost, or when the risk has been passed to the government, the supplier is likely to consider the contract a success. This may occur years before the technology-receiving enterprise is fully self-sustaining, and is obviously even more true for equipment sellers whose responsibility normally ends when the goods are shipped.

In certain cases, where continuing supplier relationships are contemplated or where the reputation of the firm is at stake, the technology supplier may apply the full operational criterion. When ownership of the technology-receiving firm is involved, through joint ventures or other arrangements, profitability is an important criterion. In a multinational operation, the contribution to worldwide operations of output of the particular enterprise is also important.

Supplier country governments may or may not take a broader view than that of the firms. Technology transfers are often viewed as foreign exchange earners unless other foreign policy or employment considerations are at stake. When output from the technology-receiving enterprises abroad competes with the supplier country's domestic industries, successful transfer from an operational point of view might be considered unsuccessful from the supplier government's perspective. Similarly, projects supported by economic assistance may be judged successful if recipients are satisfied or, contrastingly, if certain goals of operational efficiency are met.

In other words, evaluations of the success of technology transfers depend on the ranking of these various criteria. Technology absorption is one basis for evaluating the extent of transfers, but many other criteria can be applied in judging overall success. Evaluations can be based on recognizable effects or impacts which have already occurred, or on expectations about future effects. Generally speaking, when recipients are able to effectively use technologies which fit the requirements of a particular production process, they are likely to judge the technologies as appropriate.[4]

MEASURING TECHNOLOGY TRADE

Technology flows internationally through trade in machinery and equipment, investments, technical services, industrial rights, and contracts awarded. Taken together, these flows constitute international technology trade between suppliers and recipients. Such flows are only very imprecise indicators of technology transfer, but they are important in their own right because international transactions are reflected in trade balances between nations. Trade in technology is also important as the major mechanism for commercial technology transfer, and factors affecting trade also influence the technology transfer process, including technology absorption. The third section of this chapter identifies factors influencing general patterns of technology trade; chapter 4 assesses the extent and characteristics of Middle East technology trade during the past decade.

However, as important as international trade in technology is as a discrete topic, it must be distinguished from technology transfer, as used here to include technology absorption or the development of recipient capability. In order for technology transfer to occur, technology trade (or provision of technology for free through development or other assistance programs) must take place. Technology trade is thus a necessary but not a sufficient condition for full technology transfer, including technology absorption.

Since technology is not measurable in any natural unit, measurements of technology flows (technology trade) are imprecise at best and provide only the roughest approximation of the resulting level of technology absorption. Nevertheless, international flows of technology in machinery and equipment, technical documents, patents and licenses, international contracting for large projects, and investments are the channels for technology transfer. Competition for these sales among various sellers is a characteristic feature of technology trade, and the positions of U.S. firms in the international market are an important concern for the U.S. Government.[5]

. Problems with measuring international technology flows are significant and deserve attention. However, despite these difficulties, the various indicators can be judiciously used to assess international flows so long as their limitations are understood. Generally speaking, most of the various indicators include transactions other than those involving technology. In addition, the various indicators, such as equipment and machinery trade and contract awards, overlap.

Machinery and Equipment Imports

Perhaps the most easily accessible single indicator for technology trade is data on imports of machinery and equipment into recipient countries. This trade category includes capital goods, sometimes referred to as "engineering products."[6] As a data base for assessing technology trade, this category has several significant virtues: It is probably the most quantitatively complete indicator of technology flows, in that virtually all technology transfers involve imports of equipment recorded in the import accounts. It can be disaggregated to subcategories important for specific types of technology transfers (e.g., telecommunications equipment). Finally, these data reflect actual flows, rather than plans for project development.

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[4] "Appropriate technology" has been defined variously as capital-savings technology, community technology, environmentally sound and appropriate technology, soft technology, and intermediate technology. For a discussion of appropriate technology and its definitions, see *The World of Appropriate Technology* (Paris: Organization for Economic Cooperation and Development, 1983), pp. 10-11.

[5] The "competitiveness" of U.S. firms is a complex issue. See *International Competitiveness in Electronics* (Washington, D.C.: U.S. Congress, Office of Technology Assessment, OTA-ISC-200, November 1983), for a discussion of competitiveness of U.S. industry that focuses on the domestic determinants. While analysts have measured competitiveness in terms of U.S. share of world exports, there is no agreement on an approach for analyzing U.S. competitiveness in international technology trade. One approach is to look at the competitiveness of "high-technology industries," meaning those involving a high level of scientific and engineering skills, those whose R&D effort is high relative to sales, or those with a rapid rate of technological development. See, for example, U.S. Department of Commerce, *An Assessment of U.S. Competitiveness in High Technology Industries* (Washington, D.C.: U.S. Government Printing Office, 1983).

Analysis of competitiveness also depends on whether one defines U.S. firms by ownership or location of production, or both. For a discussion, see Sumiye Okubo, *Impact of Technology Transfer on the Competitiveness of U.S. Producers,* paper submitted to the Economic Trade Policy Analysis Subcommittee of the Trade Policy Staff Committee, July 18, 1980, p. 6.

In this report, OTA examines factors affecting sales of technology and equipment, and trends in market shares of supplier firms.

However, these data also have significant limitations for analysis of technology flows. Even the finer subcategories group together many types of equipment, making it impossible to clearly distinguish "advanced technology" product imports. There is, furthermore, no way to ascertain the number and types of users of the equipment, or the ancillary exports of industrial rights or human capital involved in particular instances of technology transfer. It is thus impossible to determine whether equipment is destined for an entirely new production facility or for an existing facility. Nevertheless, exports of machinery and equipment make up the largest single category of exports to the Middle East.

Technical Services

Balance of payments data also include a category for trade in services. The value of world trade in services for 1980 has been estimated at $350 billion, compared with $1,650 billion for merchandise trade. The United States was the largest exporter of services, with exports valued at $34.9 billion during that year.[7] However, aggregate data on trade in services include a number of elements (e.g., reinsurance, transactions by defense agencies, and passenger transportation) not normally included in civilian technology transfer.[8] Thus, despite the growing importance of service trade for the United States, and the importance of exports of technical services for analysis of technology transfer, there is no aggregate data source adequate for detailed analysis of service trades of particular types, such as technical services.

One recent study by the International Trade Commission carried out a survey of exporting firms in order to build a data base on trade in services.[9] The Office of the United States Trade Representative has also produced a report in support of efforts to promote liberalization of trade in this sector.

Contracts Awarded

Data on major contracts awarded, collected by trade publications, are a valuable source of information on technology trade associated with large projects. These data have some advantages. They are organized by specific projects and therefore provide an indication of technology transfer "packages." They provide information about the context of the project; for example, the names of the principal investors and the prime contractor, and the value of the contracts. However, contract data also have glaring deficiencies from the perspective of analyzing technology flows. Since the data are gathered by private sources, such as trade journals, there is no way to be certain how complete the listings are. Even some large projects may escape notice, and many small contracts may be omitted.[10] In addition, the contract data usually do not give much information on the source of the equipment, nor do they identify even large subcontractors.

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[6] Machinery and equipment imports are recorded in Category 7 of the Standard Industrial Trade Classification (SITC), which includes two revisions. The United Nations publishes a *Bulletin of Statistics on World Trade in Engineering Products* (New York: United Nations, 1983), which includes trade in SITC Revision 2, Category 7. Categorizations of high-technology products, of which there are many, all include subcategories of SITC 7.

[7] Office of the United States Trade Representative, *U.S. National Study on Trade in Services*, December 1983, p. 111. It is widely believed that official data substantially underestimate the extent of service trade.

[8] For a discussion of service trade, from a national income and product accounts perspective, see Carol S. Carson, "Net Exports of Goods and Services, 1980-82," *Survey of Current Business*, March 1983.

[9] International Trade Commission, *The Relationship of Exports in Selected U.S. Service Industries to U.S. Merchandise Exports* (Washington, D.C.: U.S. Government Printing Office, 1982).

[10] Because the principals may wish to avoid public note, some projects may not be reported, or may be reported only in part.

It is thus difficult to measure with confidence the actual shares of various suppliers, since prime contractors from different nations may differ in their reliance on international versus own-country sources. Finally, contract data record commitments to proceed, not actual exchanges. Therefore, the import of goods and services associated with a particular contract recorded in one year may not take place for years to come, and in some cases, contracts may be altered or canceled and payments may be delayed.[11]

Foreign Direct Investment

Investments abroad have been an important means of technology transfer worldwide. Since, by far, the greatest volume of transfers measured in royalties and license fees goes from U.S. firms to their subsidiaries abroad, foreign investment data are important as general indicators of potential technology flows. There are, however, significant limitations to the value of these data as a basis for analyzing technology flows. Data on U.S. direct investments are not disaggregated to show types of investments in all Middle East nations. U.S. investments in the region have been limited. The data reflect past technology transfers rather than current transactions.

In addition, these data do not indicate the magnitude of investment by joint venture partners. The reinvested earnings and other equity transaction data, which pertain to the current year, also do not necessarily indicate current technology transfers, both because they may reflect accounting oddities and because they may be invested in assets that have little to do with technology transfer, such as real estate. Data on the assets of affiliates and "new investment" are not complete or very current. Comparison of investment stocks and flows can be highly misleading, since the data on stocks may be more severely distorted by valuation problems.

Investments by Middle Eastern nations in firms in Western nations can also be a source of technology. However, available data indicate that such direct investments in the United States have so far been limited.[12] For example, some recipient firms have expanded their equity participation in Western firms in order to gain access to technology, managerial expertise, or markets. However, even if a foreign firm is purchased completely, it is not necessarily true that all of its technological capability is thereby transferred; some of its staff may depart and the operations of the firm may be changed.

Technology Licensing and Royalty Payments

Technology licensing and royalty payments are commonly used to measure aggregate international flows of technology transfer, but they are of limited usefulness in assessing transfer to developing nations. First, these data are not compiled on a sufficiently disaggregated basis to show receipts for sales in all developing nations, nor do the recipient countries provide accurate reports of payments. Not all relevant transactions are included in the data, since provision of technology in the form of cross-licensing or buy-back agreements is not recorded and those associated with joint ventures are often not systematically covered. Furthermore, these statistics record past as well as present payments for technology trade transactions.[13]

Technology transfer also occurs when supplier firms carry out research and development (R&D) activities in recipient countries. However, only about 7 percent of all R&D expenditures by foreign affiliates of U.S. multinational firms have occurred in developing nations, and only a minuscule portion in the Middle Eastern nations.[14] U.S. subsidiaries in developing nations are the major source of payments for royalties and fees made by developing nations: in 1978 their share totaled about 85 percent of all such payments.[15] Thus, among the limited transactions involving payments for industrial property by participants in developing nations, most occur between U.S. firms and their affiliates.

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[11] Postponement in payments to contractors was reported during 1982-83 in the Middle East, when government revenues were below anticipated levels owing to the fall in demand for oil. See, for example, Michael Field, "Prudent Spending Puts Saudi Spending Back on Target," *Financial Times*, Aug. 18, 1983, p. 3.

[12] According to the Department of Commerce 1980 benchmark survey of direct foreign investment in the United States, total assets of nonbank U.S. affiliates of Middle Eastern foreign direct investors amounted to about $7.3 billion out of a total of $292 billion. See R. David Belli, "Foreign Direct Investment in the United States: Highlights From the 1980 Benchmark Survey," *Survey of Current Business*, vol. 63, No. 10, October 1983, p. 28.

[13] For example, the licensee may pay fees over a period of 5 years, but the major provision of technology may occur during the earlier period.

Technology also flows through noncommercial transactions, such as technical publications and documents, education of foreign students in the United States, government-sponsored technical assistance programs, and cooperation in science and technology. However, there is no authoritative source providing aggregate data on these activities and their contribution to technology transfer, and in many cases they overlap with commercial transactions listed above. A government-sponsored technical assistance project, for example, normally involves payments by the recipient government to U.S. firms and organizations carrying out the programs in-country.

FACTORS AFFECTING TECHNOLOGY TRADE AND TRANSFER

A variety of economic and political factors affect the international flow of technology to the Middle East. The discussion that follows briefly reviews these factors.

FACTORS AFFECTING RECIPIENT DEMAND FOR TECHNOLOGY

A nation's demand for the goods and services of technology trade depends on a complex set of factors. The basic determinants are the rate of economic growth and the nature of the economic structure. In addition, a wide variety of constraining factors limit technology absorption.

The following discussion reviews major elements in recipient country demand for technology, and points to crucial institutions as the key actors in technology selection, bargaining, and utilization in Middle East nations. An important theme is that firms in developing countries, particularly those that compete in world markets, often import technology in the form of "packages." By relying on packaged technology and expatriate labor, Middle Eastern countries faced with constraints to technology transfer (arising from limited technical manpower bases and other factors) can produce products competitive on world markets.

These firms and industries must promote development of indigenous skills in order to increase technology absorption over the long term. Firms producing goods and services for local or captive markets are often required by recipient governments to introduce training and other programs in order to expand the employment and improve the skills of indigenous workers. In firms which export, as well as those producing for local markets, policymakers in crucial institutions make key decisions about the type and volume of technology imports and their utilization.

Basic Economic Determinants

For nations of the Middle East, a major stimulus to technology importation in the last decade has been economic growth based on growing oil revenues. Annual growth in the gross domestic products (GDP) of the nations examined by OTA ranged from a high of 12.1

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[14] U.S. Department of Commerce, *U.S. Multinational Companies: U.S. Merchandise Trade, Worldwide Sales, and Technology-Related Activities* (Washington, D.C.: U.S. Government Printing Office, 1983), p. 60.

[15] National Science Board, *Science Indicators—1980* (Washington, D.C.: U.S. Government Printing Office, 1981), p. 26.

percent for Iraq, to 10.6 percent for Saudi Arabia, 7.4 percent for Egypt, 7.0 percent for Algeria, and 2.5 percent for both Iran and Kuwait during the 1970-80 period.[16]

While the situation changed in the early 1980's, economic growth in most of these countries during the previous decade was stimulated by the accumulation of surplus oil revenues. During the period 1973-80, four of these six Middle Eastern nations accumulated sizable current account surpluses. Table 1 presents this data.

For all these countries, total imports grew extremely rapidly during the period, ranging from a high of 25 percent for Saudi Arabia to a low of 3 percent for Iran in real terms on an annual basis during the 1973-82 period.[17] Furthermore, government revenues, which grew at rates well over 10 percent per year in these countries, were extremely large in comparison to GDP. In Saudi Arabia, an extreme case, the ratio of government revenues to GDP was almost 63 percent during the 1975-78 period.[18] The basic economic determinants, as well as patterns in technology trade during the past decade, are analyzed more fully in chapter 4.

Generally speaking, economic growth engenders an increasing demand for technology, both in existing enterprises (to expand production) and in new industries and services. Technology imports thus reflect not only the nature of the economic structure, but also planners' expectations about the economy, including strategies about production for export or for local markets. Among developing countries, the oil-producing countries of the Middle East were in a unique position to rapidly expand their imports of technologies during the 1970's. However, the six Middle Eastern countries focused on in this report possess widely varying capital, human and natural resources available to support technology transfers, as discussed in chapter 3.

Table 1.—Cumulative Current Account Balances, 1973-80: Six Middle Eastern Countries
(million U.S. dollars)

	Total
Saudi Arabia	140,697
Kuwait	68,996
Iraq	41,252
Iran	34,481
Algeria	-9,700
Egypt	-10,248

SOURCE: International Monetary Fund, *Oil Exporters' Economic Development in an Interdependent World*, April 1983, p. 21.

Constraints on Technology Transfer

Despite the growth in imports of technology, a number of factors constrain the capacity of developing nations to utilize it. With the exception of Israel, most Middle East countries, irrespective of their gross national products, have limited science and technology infrastructures. In such countries, there may be a shortage of technical and managerial skills, owing to inadequate education, training, and research institutions, or to small enrollments in very new institutions. While leaders (including government officials and industrialists) may be extremely well educated, the labor force as a whole is generally inadequately trained in the skills required for operation of complex production facilities. A related problem is that labor markets may fail to provide the incentives (monetary and otherwise) needed to attract and retain properly skilled workers.

In some countries, public infrastructure services, such as electric power, transportation, and communications, are unreliable and thereby inhibit development of new industries and services. Expansion of infrastructure itself requires technology transfers and considerable investment of resources.

Social and cultural values also come into play. Tasks such as replacing spare parts imported from abroad, ordering custom parts to specification from local machine shops, building additions to manufacturing facilities, alter-

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[16] World Bank, *World Development Report, 1982*, pp. 112-113. Data for Iran includes the revolutionary period in 1979 and 1980. Kuwait's comparatively low growth rate reflects falling oil production during the period.

[17] Data provided in table 13, ch. 4.

[18] International Monetary Fund, *Oil Exporters' Economic Development in an Interdependent World*, April 1983, p. 45. Data on government revenues do not include Egypt.

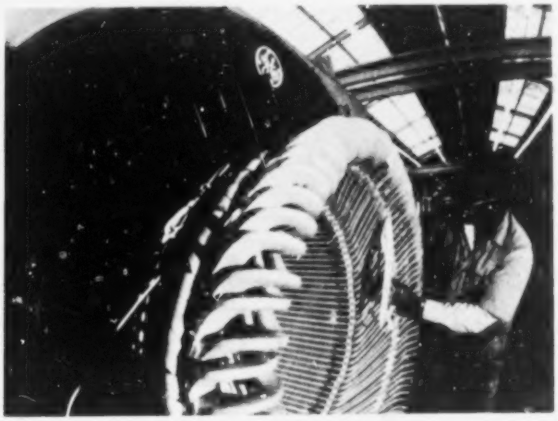

Photo credit: U.S. Overseas Private Investment Corp.

Mideast Engineering, partially owned by the General Electric Co., provides maintenance and repair services as well as technical training in Saudi Arabia. This is a project insured by the U.S. Overseas Private Investment Corp.

ing materials handling procedures to fit local conditions, or simple troubleshooting adaptations of procedures or technologies needed to get operations going after a breakdown, are difficult enough in a developing country. Where social norms emphasize authority rather than procedures, or where operations and maintenance skills are not valued, it may be extremely difficult to solve these routine operational problems.

Enterprises using imported technology are sometimes inhibited by government regulations. When spare parts sit for months in congested ports and customs areas, when permits required for minor construction are given only after long delays, and when seniority regulations require the retention of incompetent employees, the manager may find it difficult to acquire or properly utilize technologies imported from abroad. Price and economic regulations designed to produce "orderly markets" or to protect consumers may create distortions that hinder operational efficiency.

The major challenges for developing countries that have limited science and technology bases are to operate and maintain properly the technology imported from abroad. These nations usually have isolated successes in technology transfer, but failures are not uncommon. Generally speaking, the number of local manufacturing enterprises is small, and these countries often depend on agriculture or natural resource exports, tourism, or foreign assistance for foreign exchange. In some cases, a significant pool of scientific and technical manpower may be unemployed, causing "brain drain" or labor migration.

Policymakers in these countries seek to promote indigenous technological development so that the country can produce internationally competitive goods and services. Setting their sights on higher levels of economic, technological, and social development, variously defined, their goal is to enter the ranks of the newly industrializing countries. This involves installing a reasonably reliable physical infrastructure, promoting the growth of labor markets, and developing a capability in many productive enterprises not only to operate and maintain facilities, but also to adapt technology to changing market demand. For example, local engineers should eventually gain the capability to design new products which can be produced with existing or adapted technology.

Crucial Institutions and "Transfer Packages"

In developing nations, particularly those with limited indigenous technological capability, the crucial institutions involved in technology transfer are normally large, government-owned or strongly government-led organizations. These include government ministries and public enterprises. These institutions—because often they, alone, have the necessary resources—lead the process of technology transfer that results in the establishment of new production facilities.

Initially, these institutions concentrate their efforts on large-scale infrastructure projects—roads, ports, dams, large office buildings and hotels, electric power grids, central communication facilities, and airports—usually built by international contractors hired by government agencies or by multinational corporations. Sometimes the government organization is an autonomous agency, such as the Suez Canal Authority in Egypt, but often it is a section of a government ministry. The multinational firms may be minerals extraction firms, like ARAMCO in Saudi Arabia, or international food-processing firms.

The primary reason for the predominance of strong institutions is that only they are likely to have the resources (including financial resources, as well as political clout) needed to carry out large-scale importation of advanced technologies into nations with limited indigenous capabilities. These institutions often rely on technology transfer "packages" and expatriate labor in order to maximize the success of firms that produce for competitive, particularly world, markets.

Key features of transfer packages are that substantial process technology is embodied in the hardware (making it comparatively easy to use and maintain) and that considerable technical and managerial assistance is pro-

Photo credit U.S. Overseas Private Investment Corp

Suez Electronics, an affiliate of the International Telephone & Telegraph Corp., provides routine checks, maintenance, repair, and replacement for a broad range of electronic equipment as ships pass through the Suez Canal. The project is insured by the U.S. Overseas Private Investment Corp.

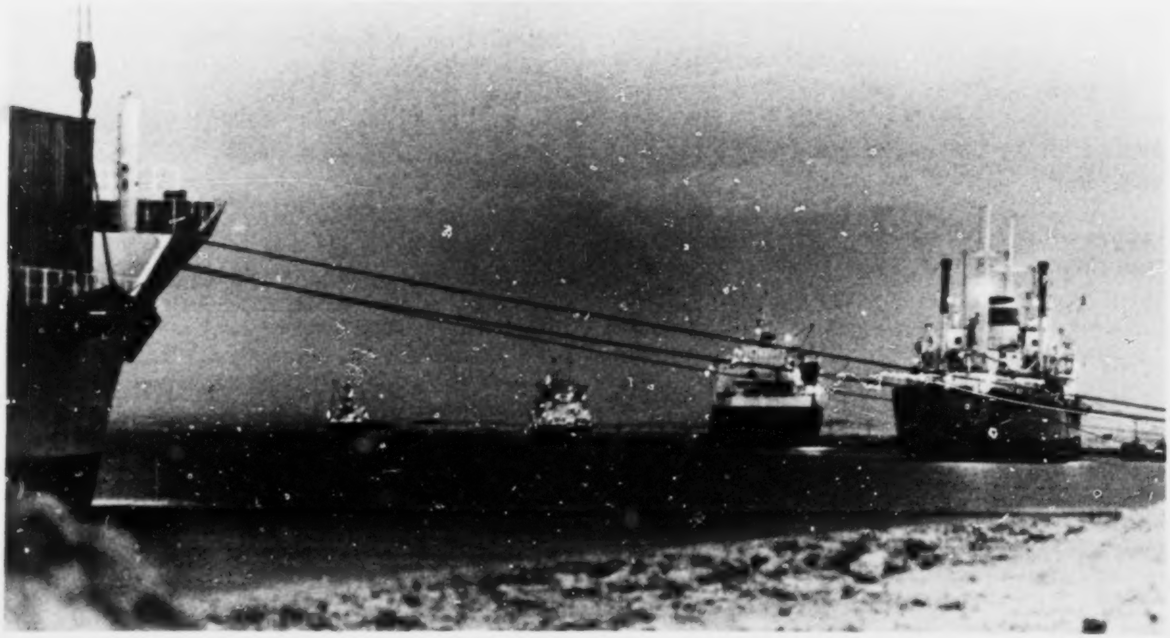

Photo credit: Agency for International Development

The Suez Canal is over 100 years old and handles an average of more than 200 ships a day, generating nearly $1 billion annually for Egypt in foreign exchange revenues vided in conjunction with the transfer. Such assistance may take the form of high-level management and technical personnel supplied on a continuing basis as part of a joint venture or subsidiary, or technical and management contracts let by an independent enterprise. Alternatively, assistance may consist of a quality-validation team sent by the equipment supplier under an offset or trademark agreement. A major feature of technology transfer packages is that they minimize the amount of technology absorption required and augment indigenous capabilities with technical assistance from abroad.

It would be a mistake, however, to conclude that transfer packages eliminate altogether the need for technology absorption. In fact, a number of factors may stimulate the need to develop indigenous capabilities. It may be necessary, for example, to change products or volumes of production to fit fluctuations in demand. In addition, managers may find it necessary to alter production processes to take advantage of low-cost materials or to take account of shortages in some kinds of inputs. These factors increase the need for adaptation of technology by the enterprise. The firm may rely on new technical assistance contracts, but some local personnel may also be involved in diagnosing the problems, selecting contractors, or (later) adapting technology.

For firms serving international markets, these demands for technology adaptation are likely to be especially strong. After initial market success, firms may find it necessary to expand the scale of production or alter processes. The urgency of such demands may be particularly great when the firm is competing with world-class manufacturers from other nations. In many cases, the requirements for technology adaptation may be so high that the enterprise has no alternative but to rely extensively on foreign technical and managerial expertise.

In contrast, firms producing goods and services for local or captive markets may find these demands less pressing, at least in the near term. In some instances, the strong institutions primarily involved in technology transfer may not be particularly efficient by international standards. Nevertheless, their existence is more or less guaranteed. Such enterprises may be required by the government to employ all, or great percentages of, local employees, and to introduce training and other programs for improving the skills of indigenous workers. This is not to say that firms producing for local markets are always less efficient than those producing for export; the nature of markets and the orientations of the firms vary.

Indeed, the capabilities of work forces to operate and maintain facilities may be improved substantially over time in firms producing for local markets, though not necessarily to the levels required for some of the firms producing for export. Because such firms are often government enterprises, their dilemma is that expansion of employment (normally promoted in labor-rich nations such as Egypt) may jeopardize operational efficiency.

Even strong institutions importing technology in packages, however, face difficult problems. They may lack the expertise necessary to make good choices of technology and to negotiate good terms. Inadequate labor markets hinder recruitment, or the criteria for selection may be so "political" that even the available skills are underutilized. In infrastructural enterprises, there may be excess demand for the services provided. These enterprises may be overstaffed, and their services may be priced below costs of production. Strong institutions may continue to operate for years in such a fashion, presenting formidable problems for leaders wishing to introduce economic and operational reforms.

Often independent local firms make smaller contributions to manufacturing production than the large government-run enterprises. Because the barriers to importation and use of advanced technologies are overwhelming for such firms, private firms need local political support; government policies are often introduced to promote their growth. As the number of such firms grows, and as they compete for shares of local markets, their requirements for technology adaptation increase. Increasingly concerned with price, quality, and marketing, the independent local firms are in that situation challenged to improve their capabilities, which they sometimes accomplish by establishing joint ventures with foreign firms.

The relationship between public and private sectors in developing nations is often a subtle and interdependent one. Policymakers in developing nations often stress the importance of private sector firms in industrialization. Nevertheless, industry remains largely under government control, and private firms are, in many instances, closely associated with government ministries. The private industries may be heavily concentrated in a few sectors and function to produce for small local markets.[19]

Regardless of whether the recipient firm is private or state-owned, its need for technology adaptation increases with expanded production of goods and services, particularly when firms serve competitive markets—international or domestic. Strong institutions play central roles in technology transfer in developing nations, but they are often unable to operate efficiently, much less to build a capability for self-sustaining technological adapation among their work forces.

FACTORS AFFECTING SUPPLY OF TECHNOLOGY AND COMPETITION AMONG SUPPLIERS

The primary factors affecting supply of goods and services of technology trade are the same economic (including the skill of individual firms in marketing their products and services) and political factors that influence international trade more generally.

Economic Factors Affecting Supply of Technology

Economic theory provides methods for analyzing why some suppliers succeed in selling technology and equipment in developing countries. The traditional theory of what determines the composition of a country's exports and imports, the factor-endowments theory, holds that a country exports goods and services whose production is intensive in the resources it has in abundance. In the United States, human capital, defined as the productive abilities of the work force over and above "raw labor," is now seen as a factor the United States has in relative abundance. Human capital is developed through education and training. It resides not only in individuals, but also in technology—blueprints, technical manuals, computer programs—and in the know-how embodied in functioning organizations. Empirical research has demonstrated that the United States exports goods and services more intensive in human capital than those we import.[20]

Although many suppliers are theoretically in a position to provide particular types of civilian technologies to buyers in the Middle East, there is a tendency for a small number of specialists to emerge. Comparative advantage and product cycle theories provide partial explanations for this specialization.

Comparative advantage is a theory which can be used to explain why particular countries export some types of goods and services and import others. The basic idea is that firms of a country export the goods and services produced with relative efficiency. (Relatively efficient production involves large amounts of the productive factors that are comparatively abundant and cheap in the country's economy.) Conversely, importers tend to import goods and services that are produced with less relative efficiency. Comparative advantage is normally visible in lower costs and prices for goods and services.

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[19] See Charles Issawi, *An Economic History of the Middle East and North Africa* (New York: Columbia University Press, 1982), discussion of Middle East industrialization, pp. 159-169.

[20] See Gary C. Hufbauer, "The Impact of National Characteristics and Technology on the Commodity Composition of Trade in Manufactured Goods," in *The Technology Factor in World Trade, Raymond Vernon (ed.)* (New York: Columbia University Press, 1970). See also Robert E. Baldwin, "Determinants of the Commodity Structure of U.S. Trade," *American Economic Review*, vol. 61, No. 3, March 1971, pp. 126-46. This research helped to unravel the "Leontif Paradox," which stated that U.S. manufactured goods exports are, contrary to expectation, less capital-intensive than its imports.

One implication of this theory is that, as the comparative advantage of the most competitive firm (e.g., a supplier of technology and equipment to the Middle East) narrows, other factors like government policies may become more important in influencing market competition. In such a situation, the ability of firms to win sales in export markets may be affected strongly by factors such as supplier government policies, in addition to the production efficiency of the firm itself.

In addition, the theory helps to clarify the fact that U.S. firms compete among themselves for exports. Therefore, a U.S. firm that efficiently manufactures technologically advanced equipment in comparison to counterparts in Western Europe or Japan (as measured in output per man hour, or other indicators of productivity) may nevertheless not export much of this equipment if there are other U.S. firms which are even more efficient producers. At the product level, it is the firms that build up comparative advantage. Because of this, it would be difficult to predict the location of the most competitive firms solely on the basis of country characteristics.

Another way to approach the question of supplier competition is through consideration of the product cycle. Basically, when the embodiment of technology in goods, machinery, people, organizational units, and systems becomes standardized, it becomes transferable to countries that provide appropriate complementary factors at lower cost. This is observable on a product-by-product basis. First, offshore production of some components occurs, followed later by full production overseas of products that were once manufactured in the originating country. This pattern has been noticeable in textiles and consumer electronics, as developing countries have become the major producers, and the industrial nations, the importers. The newly industrializing countries thus gradually gain comparative advantage in certain product lines.[21]

Both comparative advantage and product cycle theories point to the fact that U.S. firms in many cases no longer hold a strong comparative advantage in exports of machinery and equipment over firms in other industrial countries or even over firms in the newly industrializing countries. In the advanced-technology sectors examined by OTA in this study, there are often many suppliers in Western Europe and Japan producing comparable equipment efficiently. Thus, while one important factor influencing competition in the Middle East market is which firms produce at lowest costs, many other factors in practice come into play and it is often difficult to determine which are operating a particular case.

One way to gauge competition among suppliers is to look at market shares of firms from various nations. A rise or fall in the market shares of U.S. firms should not, however, be simply equated with gains or losses in competitiveness; market shares reflect a variety of other factors. First, some third country markets reflect strong historical or colonial ties to certain suppliers—Japan in Southeast Asia, the United States in Latin America. Second, if demand in the particular market is for more standardized goods and services, the U.S. suppliers would not necessarily be able to supply the demand at the lowest cost. Third, in some sectors such as telecommunications, where standards are particularly important, the initial selection of equipment may help determine which firms will be in the best position to provide follow-on equipment and services.

Finally, the over- or under-valuation of a supplier nation's currency will strongly affect exports, regardless of the productivity and efficiency of particular firms and industries. These effects may be strong in the short run, but over the long term their impact on the overall export competitiveness of nations should diminish.

Corporations compete for sales in a number of ways. Those with unique technological advantages or very efficient manufacturing processes are in a good competitive position, other things being equal. In distant third country markets such as the Middle East, the ability of supplier firms to market their goods and services may be particularly important. The costs of opening a branch office overseas may be considerable, and a new-to-market firm may be discouraged from selling abroad, particularly in unfamiliar markets. For many U.S. firms, such as those producing telecommunications equipment, the domestic U.S. market has traditionally been so large that many did not see the need to export to distant markets. Corporate strategies, therefore, are often the critical factors influencing the resources that a firm puts into marketing overseas.

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[21] G. K. Helleiner, "The Role of Multinational Corporations in the Less Developed Countries' Trade in Technology," *World Development*, vol. 3, No. 4, April 1975, p. 167.

In the Middle East, where many recipient countries face constraints in technology absorption, the willingness of supplier firms to put together technology transfer packages, including after-the-sale service and training, may also affect supplier competitiveness. Individual firms, moreover, may develop unique strategies that set them apart from other national firms. The U.S. hospital management firm Whittaker, for example, developed a strategy focusing specifically on the Middle Eastern market. Finally, willingness to participate as joint venture partners may also help firms to win contracts of certain types in some Middle Eastern nations, such as Saudi Arabia, where such partnerships are encouraged in order to expand technology transfers, among other reasons.

Political and Other Factors

Political factors often strongly influence technology trade in developing-country markets. At the most general level, long-term political relations between recipient and supplier nations (including antagonisms as well as alliances) shape the overall context within which technology trade occurs. Close political relations or alliances between supplier and recipient countries set a context conducive to technology transfer, investment, and involvement of supplier country firms. Likewise, recipient governments may attempt to reduce trade with supplier countries whose political perspectives on issues such as the Arab-Israeli conflict differ sharply with their own.

On the recipient side, contract selection for large projects may be highly politicized, and in such cases the preferences of host-country actors in influential positions may be important determining factors of supplier competition. Recipient country regulations (e.g., performance and local employment requirements) may make it easier for certain firms to win contracts.

Supplier governments also attempt to compete by assisting their own firms in a number of ways, including representing business interests abroad, negotiating on behalf of national firms, providing important market information, and enacting industrial policy measures, such as subsidies for their research activities. In addition, supplier governments can assist exporting firms by providing export credits and insurance guarantees that reduce the cost and risk to domestic firms of overseas business activities.

Since the end of World War II, an international trading regime has been established to ensure fairness in competition. The aim has been to eliminate government regulations which provide disproportionate advantages to some firms (usually national firms) over others. As a result, while direct barriers to trade have been reduced, up until recently few specific actions had been taken to affect supplier government subsidies.

The General Agreement on Trade and Tariffs (GATT) subsidies code and the Organization for Economic Cooperation and Development (OECD) arrangement on officially supported export credits are quite new and not fully tested, but their aim is to set ground rules for government subsidies. These agreements are likely to have their major effect through a combination of negotiation and deterrence, because in both cases there is incomplete coverage of countries, specific exclusions, lack of remedies, and weak enforcement. Nevertheless, such agreements do set standards for official subsidies against which deviations can be assessed. No agreements cover international trade in services—including construction, engineering, and management services—

though exploratory discussions have been held.

Only since 1982 have the minimum interest rates established under the OECD arrangement been close enough to commercial rates to make much of a difference. A large loophole remains regarding sales to developing nations: the guidelines established are not valid when soft financing is offered under the guise of official development assistance (ODA).[22] In such cases, called "mixed credit," official export credits are used in conjunction with concessional financing permitted for development assistance. OECD nations have discussed proposals supported by the United States to establish an agreement on mixed credits, but no agreement has been reached.

To summarize, despite recent efforts to eliminate unfair subsidies, in practice supplier governments determined to support their exporting industries employ a variety of direct and indirect mechanisms.

Perhaps least susceptible to international agreement are the policies which indirectly affect international technology trade included under the general category of domestic industrial policies of supplier nations. Tax benefits, R&D subsidies, and procurement practices favoring domestic firms may be used to support export industries. Government-owned telecommunications firms in some supplier nations are in a particularly good position to receive indirect supports of various types.

All industrial nations have such policies that affect international technology trade; however, it is technically difficult to measure the subsidy element and politically difficult to build a consensus concerning rules of the game. As discussed in chapters 12 and 13, the types of assistance that various Western nations provide to exporting firms reflect differing traditions of government-business relations. In some cases, the large state-owned or strongly government-led firms (particularly telecommunications firms) are the major exporters of equipment and services to the Middle East, heightening the political dimension of large contract awards.

Theoretically, competition among suppliers is determined most importantly by the ability of individual firms to efficiently produce goods and services, as compared to their competitors (including both foreign and other national firms). However, in practice, other factors come into play, particularly in situations where no firm has a clear-cut cost advantage based on the efficiency of its production, and where many firms are in a position to supply roughly equivalent technology. Analysis of competition among suppliers for sales of technology must take this wide range of factors into account.

TECHNOLOGY TRANSFER: THE POLICY ISSUES

Technology transfer, from the perspective of a policymaker, holds tremendous promise, but also potential problems. The opportunities and the pitfalls are particularly salient when technology flows from developed to developing nations; the stakes are high for recipient governments initiating new and highly visible projects involving the introduction of sophisticated technology imported from abroad. For the supplier, potential losses include growing resentment about projects that have failed, which may, in extreme cases, jeopardize foreign relations with suppliers.

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[22] In order to qualify as official development assistance, the grant element of the loan must be greater than 25 percent of the total. The grant element reflects the financial terms of the transaction: interest rate, maturity, and grace period. It is a measure of the concessionality of the loan. To calculate this benefit, the present value at the market rate and the length of time the funds are available to the borrower are determined. The "grant element" of the loan is the excess of the loan's face value over the sum of these present values, expressed as a percentage of the face value.

Technology transfers raise difficult choices for policymakers in recipient and supplier countries because it is impossible to anticipate all the future consequences or even trace the effects of past technology transfers. Because technology transfer normally occurs in the context of economic development projects, it can be viewed as a facet of the development process. Because it is related to other trends such as urbanization, economic growth, improvement in living standards, and political and social change, it is usually difficult to distinguish the discrete effects of technology transfer at the national level.

Because their potential gains and losses differ, recipients and suppliers—whether they be governments, private enterprises, organizations, or individuals—inevitably evaluate the costs and benefits of particular technology transfers in different ways.[23] Recipients and suppliers alike—forced to make choices in a context of inadequate information, experience, and capacity for anticipating results—may seek to maximize political and other goals rather than ensuring the success of technology transfer. Policy choices affecting technology transfer often reflect political compromises, foreign policy aims, and social values. The purpose of this section is to outline briefly the generic choices policymakers face as they seek to affect technology transfer.

RECIPIENT POLICY ISSUES

For developing countries, technology transfer involves learning and applying technologies imported from abroad, commonly from the industrialized nations. The Islamic countries of the Middle East have had historic ties to Europe and were among the last to experience Western colonialism. What distinguishes the region is that the end of the colonial period coincided with the discovery of oil wealth in some of these nations, providing them with unique resources for economic growth and technology transfer.[24] The oil-importing, developing nations of the region have also been affected by these developments through remittances earned abroad by their citizens, Arab economic assistance, and political-military developments in the region. However, the per-capita GNP of most developing nations remains well below that of the major oil-exporting nations.[25] For policymakers in all of these countries, however, the central question is how to use Western technology to speed economic growth and attain social prosperity and, at the same time, preserve their political legitimacy and avoid clashes with traditions.

Selection of Technologies

To recipients, a critical problem is the selection of technologies needed to attain development objectives. Technology transfer will "work" for the recipient only if the recipient knows what to ask for and if the foreign supplier is willing to provide it. Disappointment with foreign firms in technology transfer often results when the recipient does not possess the knowledge or experience needed to define requirements. In such cases, the foreign partner may meet its obligations, but the level and type of transfer may not meet recipients' expectations.

Theoretically, technology selection should fit in with a broad range of policy concerns: economic growth, international trade, and environmental, labor, and social policies. However, because policies are rarely well defined and consistent across these areas, the problems of selection are significant. A group of Kuwaiti policymakers have characterized the problem as follows:

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[23] See Joseph S. Szliowicz (ed.), *Technology and International Affairs* (New York: Praeger, 1981). See also Henry N. Nau, *Technology Transfer and U.S. Foreign Policy* (New York: Praeger, 1976), for a discussion of national perspectives on technology transfer.

[24] Dankwart A. Rustow, "Modernization, Oil and the Arab Countries," *Arab Resources: The Transformation of Society*, I. Ibrahim Ibrahim (ed.) (Washington, D.C.: Centre for Contemporary Arab Studies, 1983).

[25] Egypt's per capita GNP in 1981 was $650, while Kuwait's was $20,900, according to World Bank figures. *World Bank Development Report—1983* (London: Oxford University Press, 1982), p. 148.

> Developing countries should be selective in the type of technology they choose to meet a prescribed set of objectives and criteria. The choice of technology should be made with a view to enhancing their resource base, to suit their socio-economic setting, and to be consistent with their natural endowments (capital- versus labor-intensive). It should also meet certain environmental constraints, promote self-reliant development, strengthen indigenous research capability, and lessen technological dependence.[26]

Considering their varied resources, it is natural that Middle Eastern countries have chosen different paths to development. The Gulf States, rich in oil and gas and small in population, have made the hydrocarbon sector the focus of development. Saudi Arabia's First Five-Year Plan, for example, outlined a strategy for using oil wealth to purchase advanced technology in order to diversify the economy.[27] The question is how far diversification into steel, aluminum, and petrochemicals should be taken.[28] Some of the new heavy industries in the Gulf, such as steel, are locally marketed, while new petrochemical plants will serve export markets. Technology transfer decisions are interrelated to choices about the type and speed of development, including export and import substitution strategies.

The choices Egypt faces are strikingly different. With limited natural resources and capital, Egypt nevertheless has a wealth of human resources. Egypt's engineering and medical schools date back to the early 19th century. By 1960, the country had twice as many university students as Britain. By 1970, it had twice as many university students among Third World countries as would have been expected, given its industrial infrastructure.[29] Enjoying a large population and a comparatively high proportion of technically educated people, Egypt's challenge is to use these human resources fully, particularly in industrial development.

Policymakers in different countries may reach different conclusions about what technologies are most "appropriate," even if the national resources are comparable. Considerable attention has been paid to the potential uses of intermediate, small-scale, labor-intensive technologies by developing nations. Technologies have been defined by theorists as "inappropriate" for a number of reasons—such as failure to utilize local materials, to adapt to local markets, or to introduce suitable scale of production.[30] However, in practice policymakers determine the appropriate mix of technologies; and the long-term environmental, social, and other effects are often insufficiently considered.

Public and Private Sectors

Technology transfer also raises questions about the relationship between public and private sectors in developing nations. As discussed earlier, government ministries play central roles in making up development plans, thereby influencing the growth of the private sector. Public corporations, such as the ministries of health and telecommunications, are usually the critical institutions requiring imported technologies. In many instances, government officials plan and implement technology transfer to developing nations.

Successful transfer implies a degree of operational efficiency that is, in some cases, constrained by the presence of a large bureaucratic public sector. Such problems can be traced to high government salary scales, which draw qualified technical people from the private sector without using their talents effectively, to the need to reward political allies, and to the lack of experience of government officials with the actual workings of industry. As a general rule, where the public sector completely overshadows the private sector, technology transfer choices may be taken without sufficiently involving those who will use the technologies. As discussed in chapter 11, there is a wide range of variation in the capabilities of government institutions in these countries, but improving efficiency has been a goal in all of them.

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[26] K. Behbehani, M. Girgis, and M. S. Marzouk, "The Role of Science and Technology in Kuwait's Development: An Overview," *The Symposium on Science and Technology For Development in Kuwait*, Behbehani, et al. (eds.) (London: Longman, 1981), p. 2.

[27] Fouad Abdul-Salam Al-Farsy, "King Faisal and the First Five Year Development Plan," *King Faisal and the Modernization of Saudi Arabia*, Willard A. Beling (ed.) (London: Croom Helm, 1980), p. 63.

[28] Abdullah al-Kahlifa of the Bahrain Industry Ministry articulated the question in May 1983, when he asked: "Our declared aim is to diversify an oil-based economy. But are we doing the right thing? Is industrialization real, or is it a gold rush?" See "Persian Gulf Industrialization," *New York Times*, May 23, 1983, p. D6.

[29] Clement Henry Moore, *Images of Development: Egyptian Engineers in Search of Industry* (Cambridge, Mass.: MIT Press, 1980), p. 4.

[30] Simon Teitel, "On the Concept of Appropriate Technology for Less Industrialized Countries," *Technological Forecasting and Social Change*, vol. 11, 1978, pp. 349-369.

All of the Middle Eastern nations studied, including Saudi Arabia as well as war-torn Iraq, have announced plans to promote the growth of private sector firms and organizations in an attempt to liberalize their economies and enhance market operations. In many instances small private firms interact with and are dependent on public sector ministries for special treatment, including protection. Development of private sector firms may promote efficient use of imported technologies over the long term, but significant change in public/private sector roles may involve challenges to vested interests in public sector corporations and agencies.

The Egyptian experience illustrates problems accompanying attempts to introduce changes. Egypt's decision in the early 1970's to promote an "open door" policy for encouraging the growth of the private sector followed years of centralized planning by the public sector. However, despite the open door, the private manufacturing sector has grown slowly. (In ch. 8 the relationship of public and private sector health care enterprises in Egypt is discussed and problems relating to technology transfer are identified.)

Recipient Firms and Foreign Suppliers of Technology

In the Middle East, recipient governments have expanded regulations which help to determine the relationship between recipient firms and foreign suppliers of technology. This is analyzed more fully in chapter 11. For example, some nations encourage foreign investments through special tax policies, including free zones. Egypt's Law 43 is designed to provide incentives for the import of modern capital-intensive technologies. Saudi Arabia has encouraged the formation of joint ventures with foreign firms because these are viewed as a prime avenue for technology transfer. This approach is based on the idea that if a foreign firm is committed over the long term, successful technology transfer is more likely to result than if the firm is interested only in exporting goods. Kuwait, in contrast to Saudi Arabia, has favored a nationalization policy that stresses direct acquisition of foreign firms.

Related to these choices are larger questions about whether to pursue a strategy of technological "self-sufficiency," involving a stress on indigenous technology mastery, or to plan for long-term involvement of foreign suppliers. Laws governing investments, patents, licensing and trademarks, resolution of settlements, and trade affect the type and duration of relationships formed with foreign suppliers.

Similar decisions are made, explicitly and implicitly, concerning the role of foreign governments as suppliers of technology through development assistance and other programs. Participation of the foreign government may be extensive—in planning a technical assistance project, staffing it, and evaluating its success. Recipient countries have sometimes complained that they have insufficient opportunity to set priorities and to participate fully in such development assistance programs. In contrast to lower-income developing countries, Gulf States such as Saudi Arabia and Kuwait receive no development assistance and have become major donors themselves. Such countries may purchase technology directly from private firms abroad or enlist foreign government involvement through technical assistance projects.

In addition, developing countries have attempted to cooperate in addressing questions of relations with technology suppliers, particularly multinational firms. For a decade, developing nations have pressed for the establishment of a code to regulate international technology transfer. Access to science and technology was a primary aim of the New International Economic Order, inaugurated by the U.N. General Assembly in 1974. Developing countries argued that they were unable to bargain effectively with suppliers—that technology was too costly and that the terms of the arrangements were too restrictive. The draft International Code of Conduct on the Transfer of Technology has still not been approved.[31] Although preparation and negotiation of a draft code has continued through the fifth session of the United Nations Conference on an International Code of Conduct on the Transfer of Technology (November 1983), there appears to be little prospect of agreement in the near future.

In addition, a number of multinational conferences sponsored by various U.N. agencies and international organizations have focused on regional technology transfer problems.[32] The U.N. agency UNIDO, for example, is attempting to establish a system for monitoring technology flows in developing nations, through its Technology Exchange System and its Technological Advisory Services.[33] The more narrowly defined efforts of UNIDO and other specialized U.N. agencies have contributed to a greater understanding by developing countries of the problems of technology transfer, particularly the legal issues.

In contrast to the U.N. negotiations that involve a wide spectrum of countries, Middle Eastern nations have also established regional organizations that attempt to improve the capabilities of member states to acquire and bargain for Western technology. Such regional organizations date back to the formation of the League of Arab States in 1945.[34] Many of the more than 400 joint Arab projects actually involve only limited cooperation among member states, and some are virtually inactive.[35]

However, regional organizations such as the Gulf Cooperation Council (GCC) have recently made significant progress in economic cooperation. In December 1982, the GCC countries signed a unified economic agreement that included coordination on tariffs. Other specialized organizations, such as the Gulf Organization for Industrial Consultancy, have worked to improve the ability of member nations to select and use technology. The Islamic Development Bank has established an Islamic Research and Training Institute which aims to improve technology transfer, particularly through increased reliance on local consultants.[36] At present, there is strong interest in technology cooperation among Middle Eastern nations, but defining relations with foreign suppliers may be difficult for organizations with varied membership.

Promotion of Technology Absorption

Another set of choices for recipient countries concerns promotion of technology absorption. Recipient governments have an interest in ensuring that indigenous capabilities are improved—that technology is absorbed or mastered. Technology absorption is important for the user firms, and because it can contribute to the national science and technology infrastructure needed for society-wide development.

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[31] Dennis Thompson, "The UNCTAD Code of Transfer of Technology," *Journal of World Trade Law*, vol. 16, No. 4, July/August 1982. UNCTAD held a general conference June 6-30, 1983, and prior to the meeting, Third World countries called on the conference to improve data on technology transfer, and to explore the possibility of drafting international standards on marketing, promotion, distribution, trade, and technology in pharmaceuticals. The United States and other developed nations were criticized for not participating sufficiently in efforts to speed technology transfer to developing countries. See *U.S. Import Weekly*, May 25, 1983, pp. 301-302. See also Pedro Roffe, "UNCTAD: Transfer of Technology Code," *Journal of World Trade Law*, vol. 18, No. 2, March/April 1984, pp. 176-182 for a review of outstanding issues of debate.

[32] ECWA (United Nations Economic Commission for Western Asia) has attempted to improve understanding of problems related to technology transfer in various manufacturing sectors of this region's developing nations.

[33] UNIDO Secretariat, "Overview of Selected Problems of Technology Transfer to Developing Countries," UNIDO/LES Joint Meeting on Problems of Licensing Into Developing Countries, Vienna, Austria, June 22, 1982.

[34] See Elias T. Ghantus, *Arab Industrial Integration: A Strategy for Development* (London: Croom Helm, 1982), for a review of the arguments concerning the economic benefits of regional integration.

[35] Yusif A. Sayigh, "A New Framework for Complementarity Among the Arab Economies," *Arab Resources: The Transformation of a Society*, I. Ibrahim Ibrahim (ed.) (London: Croom Helm, 1983).

[36] Islamic Development Bank, "The Transfer of Technology and the Role of Development Financing Institutions and the Consulting Engineers," paper, 1983.

The desire to use foreign technology effectively, without relying completely on foreigners, leads to difficult choices about manpower. Saudi Arabia's King Faisal, like other Middle Eastern leaders, worried about massive infusions of Western technology:

> It is within our power, for example, to erect an enormous plant—but can we run the plant properly or get the desired results from it? In my opinion, it is far better to equip ourselves with the ability to do things on our own without relying on foreigners or on anyone else.[37]

Particularly in sparsely populated Middle Eastern countries, manpower constraints affect the extent of technology absorption. The Kuwait Ministry of Planning has forecast a shortage of skilled workers.[38] Kuwait and other Gulf States have made manpower development a high priority, but reliance on foreign workers will continue for years. There is an ample supply of Egyptian, Palestinian, and Asian workers and during 1983, when oil revenues fell, many of them were sent home. Many countries have used foreign consultants and laborers in the process of industrialization—Japan learned from foreign advisors after the Meiji Restoration, and foreign laborers helped build American railroads and run U.S. industry.

A critical question for Middle Eastern countries is how much to rely on foreign labor, particularly for professional and managerial positions. Related, of course, are issues concerning citizenship rights of foreign workers and the status of women workers. The presence of foreign labor, in itself, may not be a major problem, but related issues of indigenous skill development and efficiency of operations are certainly affected by the foreign labor mix.

These are issues of considerable controversy for Middle Eastern policymakers; rapid "indigenization" programs are costly in the short term, but complete and long-term reliance on foreign workers certainly limits domestic technological development. However, the short-term costs of inefficient production are also great, and in practice, these choices require balancing long- and short-term objectives and setting priorities for manpower development.

Technological development at a national level requires building an institutional infrastructure. This base is needed to incorporate technical, commercial, managerial, financial, and research expertise so that technical know-how will reach the users. Firms in developing countries often have limited abilities to diagnose problems or to select and fully utilize technologies. As a result, operations and maintenance of facilities are often neglected, and equipment is underutilized, or even wasted. A local technical and managerial infrastructure is thus essential for technology transfer.[39]

Foreign Policies

Decisions about civilian technology transfer affect and are affected by foreign policies. Acquisition of advanced civilian technologies can contribute to the political influence and prestige of a developing country, as well as to its economic development. Technology transfers enable developing countries to enhance their bargaining positions through the transformation of their natural resources (e.g., oil) into exports, such as petrochemical products. During the 1970's the power and influence of Middle Eastern countries rose in international politics as a reflection of rising revenues earned by application of oil production and refining technologies. This influence has extended not only to negotiations with industrial oil-consuming nations, but also through Arab aid to developing countries worldwide—especially to oil-importing Islamic countries.

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[37] Quoted in Fouad Abdul-Salam Al-Farsy, "King Faisal and the First Five Year Development Plan," *King Faisal and the Modernization of Saudi Arabia*, Willard A. Beling (ed.) (London: Croom Helm, 1980), p. 64.

[38] Behebani, et al., op. cit., p. 10.

[39] Harvey W. Wallender III, *Technology Transfer and Management in the Developing Countries* (Cambridge: Ballinger Publishing Co., 1979), p. 6.

Military and strategic considerations are sometimes important for technology transfer choices. Ongoing hostilities such as the Arab-Israeli dispute, the Iran-Iraq War, and inter-Arab rivalries have stimulated demand for military technologies. In recent years, 40 to 50 percent of the world's arms exports have gone to the Middle East. Also, the perception of Israel's technological strength, particularly in the military area, has stimulated expanded demand in Islamic nations for military and dual-use technologies.

However, these countries face difficult choices in balancing military needs against other development priorities, and they must anticipate the possible responses of other countries to their actions. Among the transfer sectors examined in this study, nuclear technology transfers most dramatically illustrate these choices. As explored in chapter 9, demonstration of nuclear weapons capability by any nation in the Middle East would very likely stimulate weapons programs in neighbor countries.

In addition, in transfering both civilian and military technologies, suppliers interact with and perhaps gain some degree of influence over recipients, and this presents important choices for recipient nations.[40] Some recipient countries have attempted to limit their dependence on any one technology supplier by "diversifying" suppliers. Others have responded by building special relationships with key supplier countries. Regardless of which approach is taken, the political and strategic dimensions of technology transfer are key considerations for recipient as well as supplier countries.

Impacts of Technology Transfers on Local Social, Political, and Economic Structures

Technology transfer is a process closely associated with a number of factors promoting rapid change in developing nations. While controversy continues concerning the precise meaning of "development,"[41] few would dispute that development is characterized by far-reaching changes. In the process of technology transfer in the Middle East, foreign values and procedures (efficiency, rationality, problem-solving) may conflict with traditional values.[42] Such conflicts may arise in conjunction with the exit of working-age males from the poorer countries or with the influx of foreign workers to the Gulf States.

Similarly, the introduction of modern communications systems into the domain of traditional desert nomads, the growth in numbers of Western-educated Middle Eastern women, and the growing desire of citizens to affect political choices in countries governed by royal families can result from exposure to Western ways. Viewed from the perspective of the governing elites, political instabilty and social discontent associated with rapid change are serious concerns.

Despite the overriding importance of the impacts of technology transfer for developing countries, it is very difficult to measure effects precisely or to anticipate all results in advance. Chapter 10 assesses the impacts of technology transfers. Political choices normally dictate who benefits from transfers, and often certain groups within society such as the middle or upper classes reap the most immediate rewards from large-scale projects involving importation of advanced technology. (The term "technology transfer," however, is not properly used to encompass all aspects of development.) Nevertheless, policymakers must calculate the combined effects that technology transfer, urbanization, and industrialization may have on domestic society and culture, and they must attempt to gauge the appropriate pace and scope of these changes.

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[40] One Middle Eastern leader noted the political dimensions of technology transfer:

> Soviet technology is communist. American technology is American, bourgeois and capitalist . . . Even when these states export their technology abroad, they are acting from political motives, as well as others, including transferring their political and social character to societies in which they are exporting.

Amir Iskander, *Saddam Hussein: The Fighter, The Thinker and The Man* (Paris: Hachette Realites, 1980), p. 371.

[41] See, for example, Yusif A. Sayigh, *The Determinants of Arab Economic Development* (New York: St. Martin's Press, 1978).

[42] Denis Goulet, *The Uncertain Promise* (New York: IDOC/North America, 1977), p. 16.

SUPPLIER POLICY ISSUES

Technology transfers raise important policy issues because supplier governments sponsor programs involving transfer and therefore have an interest in their efficient operation, and because decisions about transfer taken by private firms sometimes run counter to broader national foreign policy goals.

Economic Effects of Technology Trade and Transfer

A central set of issues concerns the economic effects on the supplier nations of technology trade with and transfer to the Middle East. While it is difficult to measure all the economic effects of technology trade and transfer on the United States, aggregate indicators (exports, foreign investment, receipts for patents and licenses, sales of turnkey plants, technical training, and managerial services) of technology trade show that U.S. firms have benefited by sales of technology, equipment, and services in the Middle Eastern market and that these sales have helped offset the balance-of-payment effects of oil imports from the region.

In most cases, technology trade and transfers from the United States to the Middle East have contributed to the growth of manufacturing and service systems that produce goods and services for local consumption. U.S. exports of telecommunications and medical equipment and services, for example, fall into this category. Supplier firms may use their revenues from technology trade to increase their production capacity, begin new marketing endeavors, and expand R&D efforts. Such exports benefit U.S. firms and the American economy more generally, as discussed in chapter 10.

In a few sectors such as petrochemicals, however, technology transfers contribute to the growth of Middle Eastern export industries. The joint venture partners and the firms licensing petrochemical technology and providing contracting services, of course, benefit. In the case of petrochemicals and a few other industries, such as textiles, transfers spur the growth of new Middle Eastern industries that compete with those in the United States and other supplier countries. In view of the worldwide overcapacity in petrochemical production, the establishment of new petrochemical plants in the Middle East will hasten the need for adjustment by U.S. firms.

Some have argued that U.S. firms do not get a fair return on the technology they sell abroad. Multinational firms, they assert, have, by transmitting American technology to foreign competitors, narrowed the technological lead of U.S. firms, eliminated U.S. jobs, and reduced U.S. domestic production. Those who hold this view argue essentially that multinational firms are not able to make wise choices and that the U.S. Government should institute new regulations to limit these activities by multinational corporations.[43]

In addition, some observers note the expansion of recipient government regulations concerning performance requirements, standards, investment, and employment as potential bargaining leverage which developing countries may use to wrest better technology transfer terms.[44] The question which must be posed, however, is whether the Government is in a better position than private firms to define economic interests.

Proponents of technology transfer feel that the commercial gains far outweigh those potential problems. The firms best able to develop technology in the United States are often those most likely to export and invest abroad. Viewed from this perspective, technology transfer is essential for continued technological development and worldwide market success. In the vast majority of cases, U.S. firms transfer technology to their subsidiaries in developing nations, thereby maintaining a measure of control.

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[43] See discussion of this position and others in Edwin Mansfield, et al., *Technology Transfer, Productivity and Economic Policy* (New York: W. W. Norton, 1982), p. 21.

[44] S. Linn Williams, "Transfer of Technology to Developing Countries," *Federal Bar News and Journal*, vol. 30, No. 5, May 1983, p. 266.

Many conclude that the net effect of U.S. foreign investment has been "good for the U.S. economy."[45] They also point out that the U.S. trade balance in technology-intensive products (as with services) has shown positive growth in contrast to the overall U.S. trade deficit. Developing countries account for 60 percent of the overall favorable trade balance and 38 percent of U.S. exports in R&D-intensive manufactured products.[46]

In the midst of disagreements about the overall economic effects of technology transfers on the U.S. economy, policymakers are faced with decisions regarding issues such as export financing. Debates over financing highlight controversies about the appropriate role of the Government in promoting technology trade and issues surrounding coordination with other suppliers. All governments provide some financial assistance for exporting firms. The U.S. Export-Import Bank provides such financing, 75 percent of which has been used for exports to advanced developing countries, in order to match financing provided by foreign governments and thereby promote fairness in competition.

As mentioned earlier, OECD nations have established general rules on interest rates for export credits through the OECD Export Credit Arrangement and separate agreements on financing of aircraft and nuclear sales. However, these agreements on official export credits cover only a small portion of total commercial technology trade. The U.S. Government has taken a lead in negotiating reductions of unfair trade barriers, but it is much more difficult to establish clear rules for domestic subsidies such as R&D grants, tax breaks, and other indirect supports often included among domestic industrial policy instruments.

Some argue that the United States must emulate the aggressive subsidy policies of other Western suppliers; others, that such actions would only accelerate movement toward use of these measures elsewhere. The opponents argue that the U.S. taxpayer should not subsidize export industries, even if taxpayers abroad are willing to do so. Chapter 13 analyzes these debates in more detail.

Role of Technology Transfer in Development Assistance

Official development assistance (ODA), or official concessional aid for development purposes, plays a relatively minor role in technology transfer compared to commercial technology trade. However, economic assistance is particularly important for the oil-importing developing nations of the Middle East. The greater part of U.S. economic assistance to the Middle East goes to Israel and to Egypt, which in 1981 received about $1.1 billion, or about 15 percent of all U.S. economic assistance worldwide.[47] The U.S. Government has an interest in ensuring that its economic assistance is effective.

One set of policy issues concerns the extent to which economic assistance should emphasize technology transfer, particularly in the manufacturing sector. During the last decade, Congress has been increasingly concerned that the science and technology component of assistance be raised so that U.S. aid programs emphasize technology rather than resource transfers. While all U.S. Agency for International Development (AID) programs involve a measure of technology transfer, in recent years about one-tenth of the total AID budget for Egypt, for example, was earmarked for science and technology.[48] Proponents of a stronger emphasis on technology transfer point to examples abroad. France, for example, in recent years has provided more for technical cooperation and has sent more personnel to work in developing nations according to OECD data.[49]

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[45] National Science Foundation, *The Effects of International Technology Transfers on U.S. Economy*, papers of a colloquium held in Washington, D.C., Nov. 17, 1973, and July 1974, pp. 4, 6 ff.

[46] National Science Board, op. cit., p. 33.

[47] For comparison, in 1981 U.S. military assistance to the Near East and Southeast Asia region amounted to $2.4 billion—almost as much as total U.S. economic assistance to the region ($2.7 billion). Put another way, 59 percent of U.S. military assistance worldwide went to Egypt and Israel in 1981. See U.S. Agency for International Development, *U.S. Overseas Loans and Grants*, July 1, 1945-Sept. 30, 1981.

[48] Third Annual Report Submitted to Congress by the President Pursuant to Section 503(b) of Title V of Public Law 95-426, *Science, Technology and American Diplomacy—1982* (U.S. Congress: Report to Committees on Foreign Affairs and Science and Technology, June 1982), p. 130.

Nor is there any firm consensus about the extent to which economic assistance should be used to promote U.S. commercial advantage. "Mixed credits," which combine grant elements with commercial loans, have been denounced by the United States, but in 1984 mixed credits were used by the United States in a few instances. In addition, U.S. development assistance is "tied" aid in the sense that procurement requirements favor U.S. firms.[50] Despite the fact that development assistance and commercial promotion are interrelated, there is no firm agreement about whether this linkage should be promoted or curtailed.

Only a small number of government-supported programs involve technology transfer to middle- and upper-income Middle Eastern countries. Included among this small group are U.S.-Saudi Joint Commission programs, valued at $580 million during the 1975-82 period and directed toward manpower, trade, industrialization, science, and technology. About 80 percent of the funds, which come entirely from the Saudi Government, are transferred to U.S. private sector firms carrying out the programs. Such programs represent a different type of assistance to nations that can well afford it.

Business-Government Relations

Technology transfer issues raise difficult questions about business-government relations, as the discussion of economic effects and development assistance illustrates. The traditional adversarial relationship between government and private business sectors in the United States is reflected in antitrust legislation, and in comparatively stringent regulations on the activities of firms overseas (tax laws and the Foreign Corrupt Practices Act).

As discussed in chapter 13, U.S. export promotion programs have been less extensive than those of some other supplier nations—not only in levels of funding, but also in institutional resources devoted to these activities. This situation contrasts with the leading role that many supplier governments have taken in carrying out "economic diplomacy" missions to developing nations and in their more consistent emphasis on routine commercial representation.

The extent to which public officials organize, facilitate, or inhibit commercial technology transfers is influenced by long-standing traditions. In the United States, perhaps more than in any other Western supplier nation, the distinction between the public and private sectors has been maintained. However, a variety of proposals to expand export programs, including mixed credits, reveal growing support for a more cooperative relationship.

Energy Requirements

Energy requirements have strongly influenced decisions about technology transfers to the Middle East, particularly for Western Europe and Japan. Oil and gas make up 90 percent of the Middle East's exports. In recent years, the dependence of Western Europe and Japan on Middle Eastern oil imports has been considerably greater than that of the United States. For the United States, oil imports from the Organization of Arab Petroleum Exporting Countries (OAPEC) have declined both absolutely and relatively since 1977-79, when they reached a peak of 3 million barrels per day, or roughly 50 percent of total oil imports. In contrast, in 1981 32 percent of French oil imports came from Saudi Arabia and 21 percent from Iraq. In 1983, about 65 percent of Japan's oil still came from the Middle East. Thus, despite the fact that U.S. oil and refined product imports from OAPEC have fallen in recent years, Western Europe and Japan remain dependent on oil imported from these countries for over half of their imports.

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[49] *Development Cooperation* (Paris: Organization for Economic Cooperation and Development, 1983), pp. 240-241.

[50] See table II.B.5, "Tying Status of ODA, 1981," *Development Cooperation* (Paris: Organization for Economic Cooperation and Development, 1982), p. 227.

Requirements for Middle Eastern oil have stimulated Western Europe and Japan to participate in development projects in the region. In some instances, firms transferring technology have been provided with oil supplies. Critics charge that when oil is used as a bargaining tool, Western nations and firms may be commercially disadvantaged or, in a more extreme case, that recipient governments may pressure them to change foreign policy positions. Both public and private leaders in Japan and Western Europe tend to view their political and economic interests as convergent in their exchange of technology for energy (see ch. 12). Nevertheless, differing degrees of reliance on energy imports from the Middle East influence technology transfer and political relations among the United States, Japan, and Western Europe, and between them and Middle Eastern countries.

Foreign Policy Goals

Decisions about technology transfer may be closely connected to foreign policy goals. The United States is the only nation that has had a formal system of "foreign policy controls," under the Export Administration Act, which empowered the President to restrict exports of various kinds for political purposes: for example, imposing sanctions on countries that support terrorist activities or violate human rights. These controls have been used to restrict U.S. exports of aircraft and helicopters to countries such as Iraq,[51] Syria, PDR Yemen, and Iran and exports of a broader range of equipment to Libya.

An ongoing and unresolved debate in the United States focuses on different assessments of the costs of such controls, measured in terms of lost markets for American goods and services versus the opportunity to take a political stand on important issues, regardless of the economic sacrifice.

Similarly, the United States is the only Western nation with a strong policy of nonsupport for the Arab economic boycott of Israel. The policy requires Government intervention to ensure that U.S. firms are not discriminated against or made parties to a boycott instituted by a foreign nation. As such, anti-boycott policies reveal familiar tensions between political principles and commercial interests.

Some observers say that U.S. anti-boycott policies play a major role in restricting U.S. exports to the Middle East (particularly inhibiting the participation of firms new to the market and those transferring technology over the long term), while others argue that firms find ways to comply with the legal requirements while simultaneously expanding sales. It is extremely difficult to assess the precise impact of these policies on U.S. technology trade and transfer with the region, since many factors affect sales and only rarely can the impact of a particular type of export control be measured.

Nuclear technology transfers represent a very special case. Among Western supplier countries, the United States has the most extensive regulations dealing with exports of nuclear materials and technologies. The United States has enacted special nuclear controls designed to limit shipments of nuclear-related equipment and materials, including dual-use items, in order to reduce the spread of technologies that can be used to develop nuclear weapons. In addition, the United States participates in the International Atomic Energy Agency (IAEA) and supports the Treaty on the Non-Proliferation of Nuclear Weapons.

While there are relatively few nuclear facilities in the Middle East today, and U.S. firms have been less involved than firms from other supplier nations, many Middle Eastern countries will make critical decisions during the next decade about the introduction of nuclear facilities. Chapter 9 assesses the prospects for nuclear weapons proliferation in the Middle East and outlines a limited number of policy options available to the United States.

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[51] Foreign policy controls affecting Iraq were terminated in 1983. However, debates continued over the question of Iraq's classification. The House of Representatives passed a version of the Export Administration Act, which reclassified Iraq. See "Congress Wrestles Over Iraq," *The Washington Report on Middle East Affairs*, Dec. 12, 1983.

U.S. civilian technology transfers can be viewed as an important foreign policy asset. The bulk of U.S. civilian technology trade and transfer currently goes to friendly countries such as Israel, Egypt, and Saudi Arabia. To the extent that such transfers result in mutually beneficial relations with recipient countries in the Middle East, they can be viewed as contributing to larger U.S. political interests there. Successful civilian technology transfers help cement political alliances with friends and allies. The U.S. Government thus has an interest in promoting them. This argument can be taken further: if the United States does not pursue active technology transfer policies, Middle Eastern countries may turn to other suppliers, including the Soviet bloc countries.

Policymakers in supplier countries must, however, take note of counter arguments. Critics point to "white elephant" projects as symbolic of technology transfers that can lead to damaged relations between suppliers and recipients. Such failures, the critics argue, signify waste of finite economic resources and also pose potential social and political problems in recipient countries. The logical extension of this argument is that since poorly planned technology transfers backfire, and sometimes reduce goodwill for the United States in the region, the U.S. Government should take a more active role in regulating commercial technology transfers.

The question of what roles supplier governments can and should play in promoting or regulating civilian technology transfers to the Middle East is complex. At its center are disagreements about the extent to which transfers have been mutually beneficial, the extent to which governments can influence the volume and type of commercial trade and transfers, and, most particularly, the question of whether governments are capable of identifying the mutually beneficial projects. Despite these uncertainties, it is clear that Middle Eastern nations place a high priority on technology transfer, and other supplier governments have generally viewed such transfers as mutually beneficial.

Cooperation With Other Supplier Countries

A related issue concerns the extent to which cooperation with other supplier countries is possible or desirable. During the 1970's, European and Japanese approaches to the Middle East were sometimes seen by U.S. observers as based on short-term economic considerations. The charge "she stoops for oil" was repeatedly leveled against these nations.[52] On a number of occasions, American policymakers criticized the Japanese for actions such as purchases of Iranian oil in 1979. Beginning with the Washington Conference following the oil shock of 1973-74, tensions among the Western allies over Middle Eastern policy became apparent. Despite calls for coordination of policies, the Western nations during the last decade sometimes diverged in their approaches to Middle Eastern issues, as reflected in various European declarations. Nevertheless, through the International Energy Agency (IEA) the Western nations managed to establish emergency oil-sharing agreements and joint goals on reduction of oil imports.

Before 1973, the European Community began talks with Middle Eastern countries and with Third World countries. The Euro-Arab dialog picked up momentum during the oil crisis as the Europeans signed the Brussels declaration, which called for bilateral cooperation agreements and included a statement of opposition to Israeli occupation of territories held since 1967. The European approach favoring negotiations with oil-producing countries appeared to run counter to U.S. calls for cooperation among suppliers. (As discussed in ch. 12, the Euro-Arab talks have progressed slowly, due in part to Arab desires to include political as well as economic and technology issues in the discussions.)

These multilateral approaches reveal problems in alliance politics. Despite efforts to coordinate Western energy and foreign policies through the IEA and the Euro-Arab dialog, supplier governments have commonly formulated bilateral policies with specific Middle Eastern countries. These bilateral ties continue to be of primary importance for technology trade.

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[52] See Dominique Moisi, "Europe and the Middle East," *The Middle East and the Western Alliance*, Steven L. Spiegel (ed.) (London: George Allen & Unwin, 1982), p. 18.

Through the United Nations, the World Bank, and other multinational institutions, supplier countries cooperate in programs involving technology transfer. Technical assistance, however, is generally carried out in bilateral programs that are not coordinated. Given the growing importance of technical assistance to developing nations, some observers have called for improved cooperation among suppliers. Nevertheless the different perspectives of various OECD nations on development assistance and the strongly commercial flavor of many bilateral programs reduce the prospects for multinational coordination.

For policymakers in supplier countries, decisions about how and when to cooperate with other suppliers are often difficult. At a fundamental level, the supplier countries and their respective firms compete with one another for shares in third country markets. On the other hand, many of the largest industrial projects involve firms from many nations working together. Indeed, the internationalization of U.S. firms (by virtue of their overseas subsidiaries and joint ventures) complicates assessment of national market shares.

POLICY TRADEOFFS

Both recipients and suppliers are forced to balance various economic, social, political, and strategic considerations in formulating policies affecting technology transfers. Supplier, and especially recipient, countries and regional organizations are currently attempting to coordinate such policies.

Over the last decade, a number of proposals have been made for a more coordinated, comprehensive U.S. technology transfer policy, but none of them have been enacted.[53] This reflects, at least in part, the complex policy tradeoffs that transfer decisions raise for policymakers. Should taxpayers subsidize domestic manufacturers through "tied" aid? Are development assistance goals jeopardized by the involvement of profit-maximixing firms? Public and private sector interests sometimes diverge in transfer choices. U.S. anti-boycott policies and foreign policy controls illustrate the tradeoffs between promoting commercial gains and upholding political principles. Recipient country governments face equally difficult but different types of tradeoffs which often center around maximizing goals such as indigenous manpower development in the short or long term.

Because most technology transfers occur through commercial channels, specific supplier government policies have limited effects. (The role of the recipient governments is normally stronger, given the prevalence of public sector enterprises in developing nations.) On the other hand, the general context of foreign relations between supplier and recipient countries importantly affects prospects for technology transfer. Conversely, transfers also have implications for those foreign policies. Examples of technology transfers that failed, creating resentment on the part of recipients and perhaps financial dilemmas for suppliers, lead to a cautious approach by both sides.

Policymakers are wary of unanticipated social and political consequences that accompany rapid change. On the other hand, the promise of mutually beneficial transfers is clear. For countries determined to foster economic prosperity, such transfers are a critical element in development planning. For supplier nations, they are a factor in international competition. As recipients and suppliers learn more about how technology transfers can be designed for mutual benefit, the risks for both sides may be somewhat reduced. However, it is inconceivable that they will be eliminated, and this heightens the importance and difficulty of policy choice.

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[53] See, for example, Committee on Science and Astronautics, U.S. House of Representatives, hearings, *International Science and Technology Transfer Act of 1974*, May 21, 22, and 23, 1974.

CONCLUSION

Technology transfer, as the concept is used in this study, refers not only to international trade in technology but also to the process of technology utilization or absorption by the recipient. This chapter has outlined an approach to analysis of technology transfer which includes evaluation of the extent of technology absorption at the firm or sector level, as well as consideration of factors affecting technology trade. While no single indicator can be used to measure technology transfer precisely, technology trade and absorption can be analyzed by considering a number of relevant indicators.

As used in this report, technology transfer involves trade in technology but is not synonymous with it. It involves the development of a capability by the recipient to operate a production facility or service system at a higher level, and this implies a two-way interaction between supplier and recipient. In technology transfer, teaching and learning usually occur over a period of time, particularly when technology is transferred from industrial to developing countries. The extent of transfer is appropriately assessed at the project or sector level because the resulting capability is specific to a particular production or service system.

Technology trade—including international flows of technology in machinery and equipment, patents and licenses, technical documents, technical services and training—is important in its own right, because of its significance in national trade balances. It is also a necessary but not sufficient condition for full technology transfer, including technology absorption. The growth of technology trade indicates the potential for technology transfer, and trade may have beneficial effects even if full transfer does not occur. Factors affecting technology trade include a number of economic trends such as the level and rate of economic development, foreign exchange availability of the recipient, and the comparative advantage of suppliers, product cycles, and exchange rates. In addition, political factors such as industrial, labor, and science and technology policies as well as foreign relations between nations influence technology trade.

Recipients in developing countries often stipulate that considerable technical training and assistance be carried out in association with imports of technology in the form of equipment and machinery. By packaging technology, the supplier may be able to reduce the effect of obstacles to operation and maintenance of facilities, such as shortages of technically trained manpower. Over the long term, however, firms and users in recipient countries must develop their indigenous technological capabilities in order to attain higher levels of technology absorption needed for adaptation of technology.

The effects of technology transfer are most clearly identified in the projects or industrial sectors receiving technology. Improvements in the operational efficiency of the facility and the quality and capabilties of the work force, among other factors, indicate technology absorption. It is much more difficult to assess all the impacts of technology transfer. This is the case because it is difficult to establish the precise contribution of transfer (as distinguished from other aspects of development), to changes in customs or values, or political stability. Nevertheless, because advanced technology transfers often occur in the context of highly visible development projects, their success or failure may be viewed by recipients as symbolic of larger relations between countries.

Because it is often difficult to anticipate future effects of technology transfers or to trace past results, the transfers raise complex issues for policymakers in both recipient and supplier nations. These issues are rarely systematically addressed, and often implicit in policy debates. In many cases, tradeoffs among political, economic, social, and foreign policy goals must be made in formulating policies. Careful examination of past experience with technology transfers may help policymakers to reduce their risks and enhance their benefits. However, given the problems in assessing transfer discussed in this chapter, uncertainty about effects will inevitably remain a feature of policy choice.

The chapters that follow are designed to assess the process of technology transfer and to identify public policy issues for the United States. As a foundation for this analysis, the Middle East context and technology trade patterns during the past decade are examined. Then the process of transfer in particular sectors is assessed, with special attention given to issues of competition among suppliers and technology absorption by recipients. Policies of various recipient and supplier countries are outlined and compared to U.S. policies. Finally, U.S. policy options are identified with a view toward future prospects for Middle East technology trade.

CHAPTER 3

The Middle East as a Context for Technology Transfer

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CHAPTER 3

The Middle East as a Context for Technology Transfer

INTRODUCTION

In the 1970's the rapid expansion of oil wealth in some Middle Eastern countries at early stages of economic development was the major stimulus for technology transfer. Dependence on oil for revenue, limited infrastructure, a scarcity of technically trained manpower, and political and social tensions among and within Middle Eastern countries have at times, however, posed constraints.

This chapter outlines opportunities and constraints for technology transfer to Islamic countries in the Middle East. Two overarching themes form the context for technology transfer to the Middle East. The first is the disparity between human and natural resource endowments that characterizes the region as a whole. With the exception of Iran, those countries with larger populations have relatively low petroleum reserves. This basic imbalance is perhaps the most important feature of the Middle East context for technology transfer. Neither population nor oil resources are static, but they are critical parameters for economic and technological development in the near term. Technology transfer is thus constrained more in some countries by limited capabilities to purchase advanced technology, and in others by a scarcity of indigenous technical manpower.

Social and political concerns also shape the context for technology transfer to the Middle East, but in so many ways that it is impossible to generalize. As Middle Eastern countries attempt to combine Western technology with traditional values, the role of Islamic tradition and culture becomes difficult to define: sometimes it may support transfer, at other times it may be an impediment. Regional conflicts often limit prospects for civilian transfer; on the other hand, opportunities for regional cooperation are also available in joint economic development projects.

No one context, of course, can be considered optimal for technology transfer. Opinions vary about the significance of particular factor endowment mixes (involving land, labor, and capital resources) and of sociopolitical factors. A country with a high level of capital availability and a highly educated pool of scientific and technical manpower would certainly be more capable of obtaining and using imported technology than one that has neither the financial resources to purchase technology nor the human capability to use and absorb it.

Technology can itself be considered an additional resource. While requiring other inputs to be effective, technology can also be used so as to substitute for resources in short supply. Viewed from this angle, the challenge is to carry out transfer of technologies that will utilize existing factor endowments in the most effective way. In order to do this, a variety of technologies are needed. For these countries, importation of less sophisticated technologies may be critically important in some sectors, while advanced technologies are needed in others.

Definitions of the Middle East region range from the borders of the Arab states and Israel to the much broader region of Muslim states extending into North Africa, Asia, and the Soviet Union. The region represents a broad mix of resource endowments, levels of industrialization, and social and political systems. The countries of the region also vary in the levels and types of their technology imports, their technology suppliers, and hence in their prospects as potential markets for Western goods and services.

This report focuses primarily on six countries—Algeria, Egypt, Iran, Iraq, Kuwait, and Saudi Arabia. OTA recognizes that the six nations selected for special attention in this study are by no means representative of the Middle Eastern region as a whole, however defined. They do not include the poorest states of the region, such as the Sudan; the more radical states, such as Libya; or any non-Islamic country in the region. They also do not include the region's most technologically advanced country, Israel, since the main focus of the report is on those Middle Eastern countries which only in the past 10 to 15 years have tried to bridge the development gap very rapidly. Israel's distinct historical experience and technological capabilities put it in a separate category, one that presents different issues and problems for technology transfer than those in the six countries under review.

OTA's selection is intended to highlight key elements that present different opportunities and dilemmas for technology transfer. All of the countries in this study, for example, are oil producers, share a common Islamic heritage, are located in a hostile desert geographical context, and are attempting rapid economic development based largely on revenues from oil and gas. The differences among them, however, are striking and lie chiefly in levels of hydrocarbon reserves and production, financial reserves, economic structure, population size and composition, social and political systems, and past experience with technology transfer.

This chapter describes the context in which technology transfer occurs and in which policy decisions must be made. The major part of the chapter discusses the natural, financial, and human resources of Middle Eastern countries of particular interest. In conclusion, the social and political context is briefly considered. Questions of how Middle Eastern leaders develop policies to utilize these resources are addressed in chapter 11.

NATURAL RESOURCES AND ECONOMIC STRUCTURE

Figure 3 illustrates the disparity in the Middle East between human resources and petroleum reserves. Oil reserves in the Middle East have been the key source of revenues and the basis for industrial development in all of the countries selected by OTA. These reserves are especially large in Saudi Arabia and Kuwait; reserves in Algeria and especially Egypt are more limited. In contrast, the manpower base for technology transfer is larger in Algeria and Egypt, while being much smaller in Saudi Arabia and Kuwait.

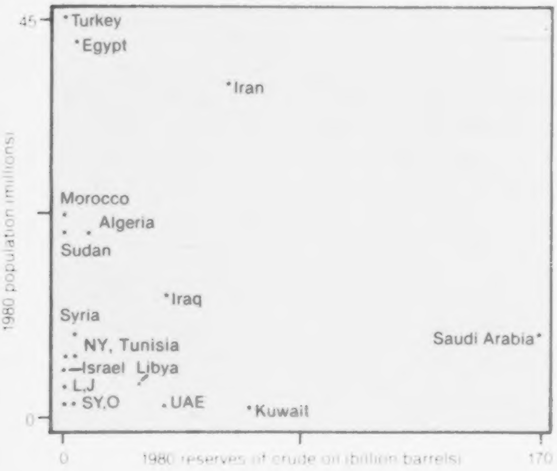
The positions of these countries change, however, when viewed from different perspectives. Petroleum revenues in relation to production contrast sharply with the same relationship on a per-capita basis. A comparison of figures 4 and 5 shows how the positions of various countries change when crude oil reserves are calculated on a per-capita basis. As illustrated by figure 5, Kuwait, a small city-state northwest of the Persian Gulf, has the highest per-capita oil reserves of any Middle Eastern country. In contrast, Kuwait ranks on a par with Iran (fig. 4) when total oil reserves are compared. Disparities also exist among the countries in both gross domestic product (GDP) and gross fixed capital formation (GFCF) per capita, as well as in the relationship between the two (figs. 6 and 7). Kuwait emerges as the high extreme when these indicators are examined on a per-capita basis, while Saudi Arabia and Iran were the high extremes on the basis of sheer wealth and investments in infrastructure, irrespective of population size.

NATURAL RESOURCES

Petroleum

The six countries included in this study are similar in their present emphasis on hydrocar-

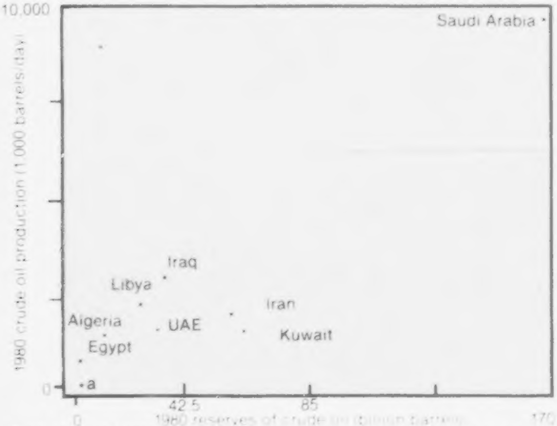
Figure 3.—Population Compared to Crude Oil Reserves, 1980



L = Lebanon
J = Jordan
O = Oman
SY = (PDR) Yemen
NY = Yemen Arab Republic

SOURCES: International Monetary Fund, *International Financial Statistics Yearbook, 1982*, and Energy Economics Research Ltd., *The "Oil and Gas Trends" Statistical Review 1981* (Reading, United Kingdom).

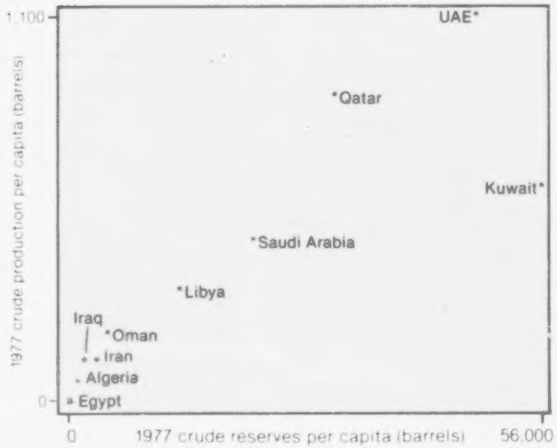
Figure 4.—Crude Oil Production Compared to Crude Oil Reserves, 1980



[a]Production and reserves are negligible for Bahrain, Israel, Lebanon, Jordan, Morocco, the Sudan, North Yemen, and South Yemen.

SOURCE: Energy Economics Research Ltd., *The "Oil and Gas Trends" Statistical Review 1981* (Reading, United Kingdom).

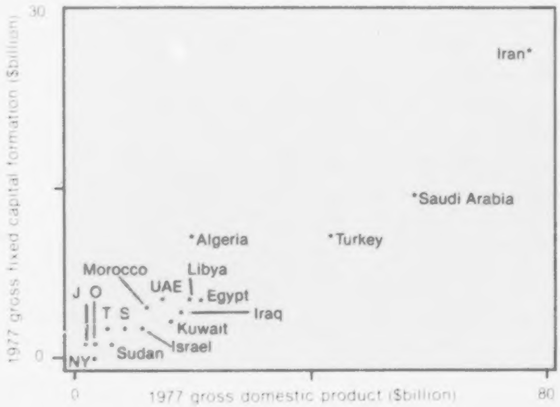
Figure 5.—Crude Production Per Capita Compared to Crude Reserves Per Capita, 1977



[a]Includes Egypt, Israel, Jordan, Lebanon, Syria, North Yemen, South Yemen, Morocco, Sudan, Tunisia, and Turkey.

SOURCES: International Monetary Fund, *International Financial Statistics Yearbook, 1982*, and Energy Economics Research Ltd., *The "Oil and Gas Trends" Statistical Review 1981* (Reading, United Kingdom).

Figure 6.—Gross Fixed Capital Formation Compared to Gross Domestic Product, 1977

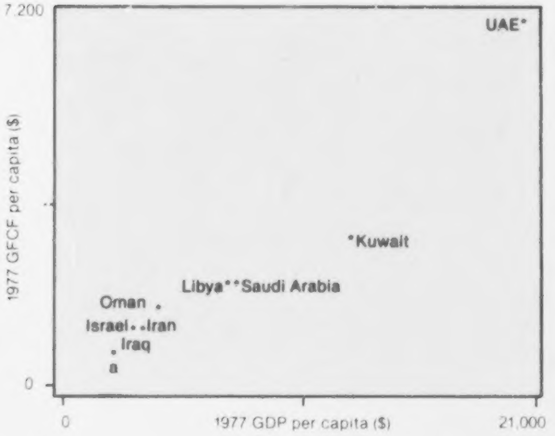


T = Tunisia
S = Syria
J = Jordan
O = Oman
NY = North Yemen

Note: The IMF does not publish national accounts statistics for Bahrain, Lebanon, Qatar, and South Yemen. They are not included in this figure. Gross Capital Formation is used for Israel. Iraqi GDP data is from 1976. Iraqi GFCF data is from 1975.

SOURCE: International Monetary Fund, *International Financial Statistics Yearbook, 1982*.

Figure 7.—Gross Fixed Capital Formation Compared to Gross Domestic Product Per Capita, 1977



[a]Includes Egypt, Morocco, Jordan, Syria, Tunisia, Turkey, Algeria.

Note: The IMF does not report national accounts statistics for Bahrain, Lebanon, Qatar, and South Yemen. They are not included on this figure. Gross Capital Formation is used for Israel and Oman. Iraqi GDP data is from 1976. Iraqi GFCF data is from 1975.

SOURCE: International Monetary Fund–*International Financial Statistics Yearbook*, 1982.

bons as a source of their revenue and growth. To be sure, the centrality of petroleum is a comparatively recent development in some of the countries under review. But today, oil and gas account for over 90 percent of total merchandise exports of five of the six countries under review, and for a large proportion of domestic production.

Even in Egypt, the country with the smallest oil resources, petroleum has recently become centrally important. Through the 1960's, for example, Egypt was the world's leading producer of cotton fiber and a major producer of other agricultural products. Today, however, with population growing rapidly, Egypt has become a net **importer** of many basic food products, and in recent years, the importance of cotton exports has declined. Instead, Egypt relies increasingly on petroleum and worker remittances for export revenues; in 1981, oil revenues accounted for 70 percent of Egyptian export earnings.

Aside from Iran and Iraq, the emergence of the Middle East as an important petroleum exporting region dates only from the middle of this century. Before World War II, few countries besides Iran and Iraq had discovered or developed oil resources. While oil had also been discovered in Saudi Arabia and Kuwait before the war, exports became significant only in the mid-1940's for Saudi Arabia, and later in the decade for Kuwait. At the beginning of the 1950's, development of Middle Eastern oil was still in its early stages; in the next 10 years, production nearly tripled, and in the following 10 years, it tripled again. Oil output in the Middle East rose from nearly 10 million barrels per day (b/d) in 1967 to 22 million b/d in 1977, an annual increase of 8.3 percent; by 1977, the Middle East alone accounted for over 36 percent of total world output and about 60 percent of total world exports.[1]

Despite the common importance of petroleum, however, there is a sharp division between the oil-rich countries and those less well endowed with hydrocarbon resources. Table 2 and map 1 illustrate some of the major differences in oil reserves, production, and exports among the six countries examined, with Saudi Arabia, Kuwait, and Iran at one end of the spectrum and Egypt and Algeria at the other. Saudi Arabia's huge proven oil reserves, for example, estimated at 165 billion barrels in 1983, vastly exceed by as much as 18 and 50 times those of Algeria and Egypt, respectively.[2] Saudi Arabia's close to 10 million b/d in crude oil production in 1981, was more than 16 times that of Egypt.[3] Similarly, Saudi Arabia's 9.3 million b/d petroleum exports vastly

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[1] Peter Mansfield, *The Middle East* (Oxford: Oxford University Press, 1980), p. 87.

[2] The World Bank cites Egyptian oil reserves at 2.9 billion barrels. An estimate of 3.3 billion barrels is included in "Economic Trends Report: Egypt," Economic and Commercial Sections, American Embassy, Cairo, Egypt, Sept. 6, 1982, p. 10.

[3] In 1977 before the Iranian Revolution and the outbreak of war between Iran and Iraq, Iran, Iraq, Saudi Arabia, and Kuwait accounted for about one-third of total Middle East crude oil production, and Iran and Saudi Arabia numbered among the four largest producers in the world. See Mansfield, op. cit., p. 89.

Table 2.—Oil and Gas in the Middle East

	Reserves		Production				Exports			Apparent consumption	
	Crude oil (billion bbl)	Natural gas (trillion ft³)	Crude oil (1,000 bpd)		Total prod. Nat. gas (billion ft³)		Crude oil exports,	Refined petroleum product	Dry gas,	Petroleum (thousand bpd),	Dry gas,
	1981	1981	1971	1980	1979	Dry gas	1979	exports, 1979	1979	1979	1979
Kuwait	67.9	33.2	2,625	1,656	460	213	2,081	294	0	154	213
Algeria	8.2	131.5	1,294	1,012	1,539	520	1,082	71	393	104	129
Egypt	2.9	3.0	542	595	ND	ND	267	33	ND	226	ND
Saudi Arabia	168.0	112.4	9,835	9,900	1,786	390	8,818	429	0	415	390
Iran	57.5	485.0	3,178	1,662	1,401	512	2,407	141	154	532	358
Iraq	30.0	27.5	3,487	2,514	509	60	3,275	42	ND	131	ND

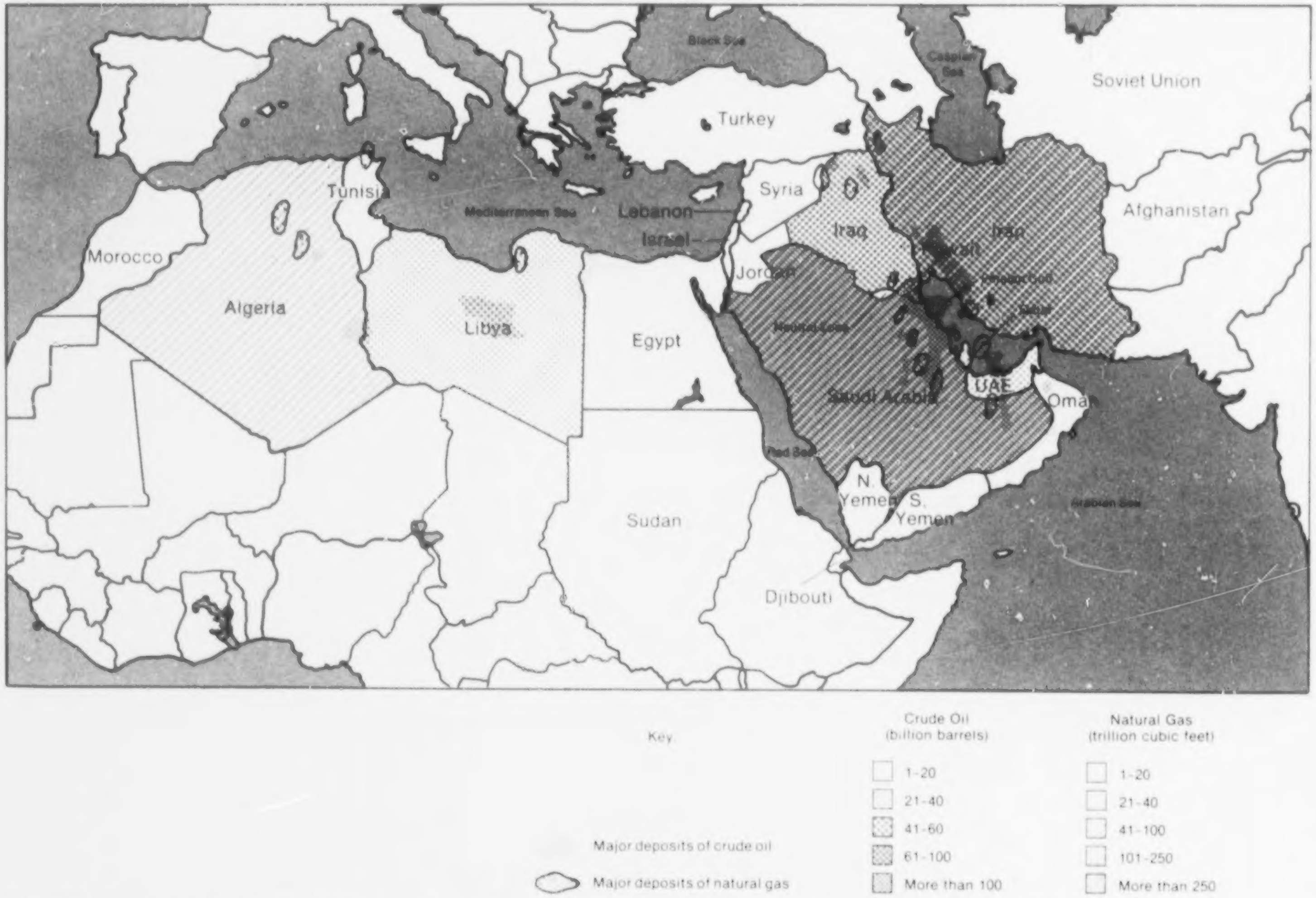
ND = no data.

SOURCE: Energy Information Administration, U.S. Department of Energy, *International Energy Annual 1980* (Washington, D.C.: U.S. Government Printing Office, September 1981), pp. 28, 29, 66, 67, 86.

Photo credit: United Nations (B. P. Wolp (LS))

Egypt's population is concentrated in the Nile Valley, and Cairo (shown here) is the largest city

Map 1.—Oil and Gas Reserves in the Middle East



NOTE: The delineation of boundaries on this map must not be considered officially accepted. Geographic names or their spellings do not necessarily reflect recognition of the political status of an area.

SOURCES: Office of Technology Assessment; oil and gas reserves from U.S. Department of Energy, *1982 International Energy Annual* (Washington, D.C.: U.S. Government Printing Office, 1983), p. 80. Location of oil and gas fields from Michael Dempsey, *Atlas of the Arab World* (New York: Facts on File Publications, Nomad Publishers Ltd., 1983), p. 17.

exceeded the 199,000 b/d of crude oil exported from Egypt in the same year. In the 1970's, Saudi Arabia and Iran were the two largest oil exporters in the world, and oil revenues in Saudi Arabia were the largest in the world.

While reserves are large in Iraq and Iran, the war between them has resulted in greatly reduced petroleum exports. This has been true especially in Iraq, where petroleum exports were at a record low of less than 1 million b/d as of 1983 in contrast with three times that level before the outbreak of hostilities.

In some countries, such as Algeria and Iran, natural gas has also been important. Table 2 highlights some of the major differences in natural gas reserves, production, and exports.[4] As table 2 illustrates, dry gas exports have been very important for Algeria and Iran in particular, whose reserves of natural gas are among the world's four largest. In 1983, Iranian proven natural gas reserves, estimated at about 483 trillion cubic feet (ft^3), were second only to those of the Soviet Union. During the 1970's, Iran was the largest natural gas exporter in the Persian Gulf. Algerian natural gas reserves have been estimated as fourth in magnitude after the Soviet Union, Iran, and the United States.[5]

Photo credit: Aramco World Magazine

Butane and propane liquefied gases are stored in special refrigerated tanks prior to export from Saudi Arabia

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[4] For the Persian Gulf region, proved natural gas resources have been estimated at about 700 trillion ft^3, or about 26.6 percent of the world total. In 1980 the aggregate gross production of natural gas in the Persian Gulf countries was 4.3 trillion ft^3. But 60 percent of this was flared, and less than 5 percent reinjected into oil reservoirs. See U.S. Department of Energy *The Petroleum Resources of the Middle East*, Foreign Energy Supply Assessment Program Series (Washington, D.C.: Energy Information Administration, May 1983), p. 75.

[5] See U.S. Department of Energy, *The International Energy Manual, 1982* (Washington, D.C.: U.S. Government Printing Office, September 1983), p. 80. In 1981, Algeria possessed an estimated 131.5 trillion ft^3 of natural gas reserves, and approximately 29 trillion ft^3 of probable and possible reserves; this did not include an additional 1.5 billion barrels of liquefied petroleum gas. Dry gas exports from Algeria in 1979, at close to 400 billion ft^3, were higher than most other countries in the Middle East, and more than 2½ times those of Iran.

In Egypt, natural gas reserves are far more limited but not insignificant. Egypt's proven natural gas reserves are now estimated at between 5.5 and 7 trillion ft^3.[6] Although natural gas reserves in Saudi Arabia, at about 121 trillion ft^3 in 1983, are fifth in size, in Saudi Arabia and Kuwait the production of natural gas has been small relative to oil, and almost all has been associated gas (i.e., gas produced in conjunction with petroleum extraction operations).

As discussed in chapter 14, however, prospects for oil and gas production in the Middle East are uncertain. On the one hand, some observers argue that oil reserves may be significantly depleted in many Middle Eastern countries by the beginning of the 21st century. One study conducted by the Department of Energy (DOE), for example, projects that if the average production during the 1990's were to remain the same as that in the 1980's, then by the year 2000 over one-half of the total known oil resource base in the Persian Gulf would be depleted.[7] On the other hand, large reserves can be expected to remain in the Middle East for the next two decades, and oil resources are not static. Several Gulf States will be able to produce some additional deposits, using more costly secondary recovery techniques, and large oil fields may yet be discovered. In addition, the importance of natural gas may rise greatly during the post-1990 period, offsetting the projected decline in oil production.

Water

Aside from oil and natural gas, the natural resources of all six countries selected by OTA are limited. With a minimum of 40 percent of the land mass of these countries classified as desert--and in some instances, more than 90 percent—the limited amount of cultivable land in these countries makes extensive agricultural development difficult. The Arabian peninsula is the most arid part of the Earth, with Saudi Arabia the largest country in the world having no rivers and few streams. In the other countries under study, basic resources for agricultural expansion—mainly water—have been limited as well, and prospects for substantial improvement are uncertain.

The scarcity of water is a critical constraint in most of the countries under review, although the situation has been alleviated somewhat in recent years by desalination and the construction of dams and irrigation systems. All of these countries have upgraded the delivery of potable water, particularly in urban areas. The Middle Eastern region is fed by two main river systems: the Tigris-Euphrates and the Nile. These two river systems have been the lifeline of this region for centuries, and the heart of great ancient civilizations. Both systems, however, are today limited in their ability to support the region's rapidly growing population.

Agriculture

Limited water availability has precluded extensive agricultural development. Most extreme in this regard are Saudi Arabia and Kuwait, with well over 90 percent of their land mass in 1982 classified as desert. Although there is some variation among the countries under review, all have considerable expanses of unpopulated land, with a few areas of dense population. Cultivable land is generally restricted to small areas lying between vast stretches of desert and steppe. In Iran, for example, more than 50 percent of the total land area has been classified as desert, wasteland, or barren mountain range of no agricultural value. In the late 1970's, only 15 to 16 percent was regarded as land that could be farmed with adequate irrigation.[8] In Egypt, agricultural cultivation has been limited to only 4 percent of the country, with harsh desert compris-

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[6] Ibid., p. 80; and "Economic Trends Report: Egypt," Economic and Commercial Sections, American Embassy, Cairo, Egypt, Sept. 6, 1982, p. 10.

[7] U.S. Department of Energy, *The Petroleum Resources of the Middle East*, op. cit., pp. 67, 82. These estimates are based on the assumption that oil production will increase at an average rate of 6 percent in the 1980-95 period; during recent years this has not actually occurred.

[8] Richard F. Nyrop (ed.), *Iran: A Country Study* (Washington, D.C.: Foreign Area Studies Series, The American University, 1978), pp. 330-331.

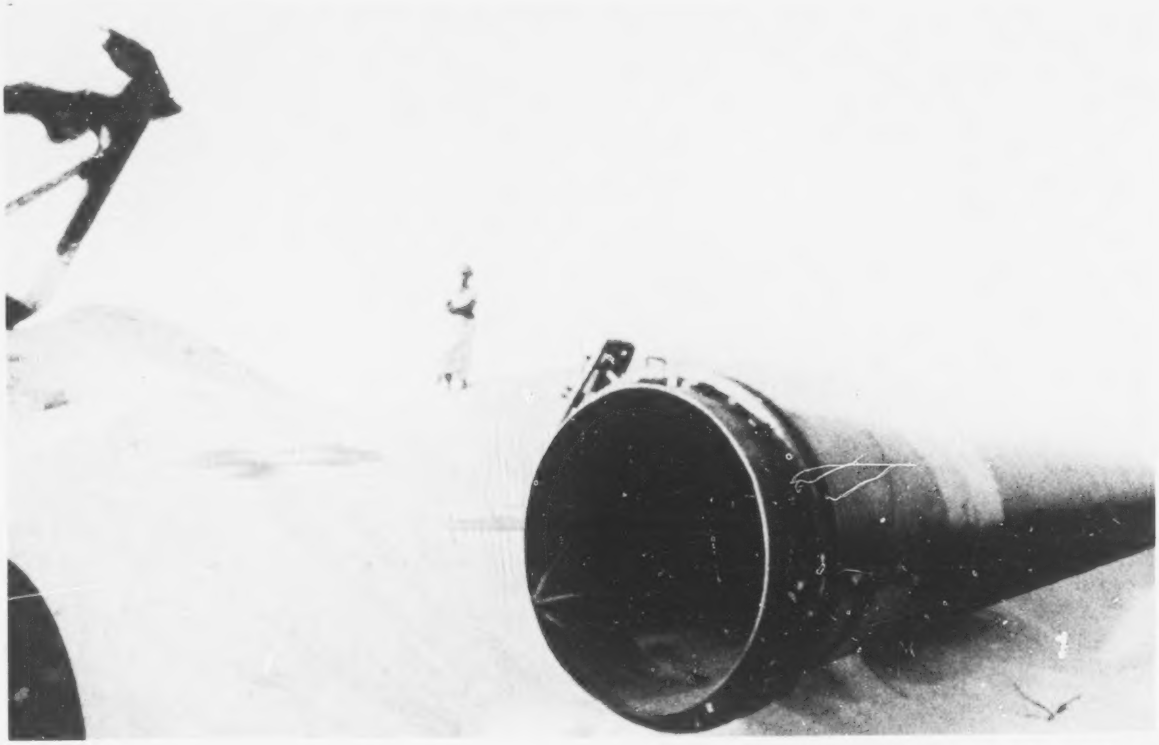

Photo credit: Chevron U.S.A. Inc

Pipeline construction in Saudi Arabia

ing much of the remainder. In only a few of the other countries in the Middle East outside of the six examined by OTA—such as the Fertile Crescent in Syria—can greater wealth in agricultural land be found, but even here, rainfall is uncertain, and the amount of cultivated land small.

This is not to suggest that agricultural products have been insignificant for domestic consumption or as sources of income for most of these countries. Aside from hydrocarbons, agricultural products have comprised the bulk of exports from many of them, including such items as barley, wheat, and dates from Iraq, cotton from Egypt, and dried fruit from Iran. But the resources for agricultural expansion have been limited, and the climate for expansion of crops much less favorable than in other parts of the developing world.

The further development of agricultural resources is an open question. The extent of underground water resources in the Egyptian and Arabian deserts has yet to be fully determined, and in Egypt, there has been some debate over whether agriculture there has actually reached its limits, given Egypt's physical environment (sun, soil, and water). Israel's success in agricultural production with limited resources is perhaps a case in point. For the time being, however, harsh climate and terrain make the region an importer of many food and agricultural products.

Minerals

The six Middle Eastern countries selected by OTA may have significant reserves of minerals, but they have not been extensively developed. Saudi Arabia and Iran, for example,

Photo credit: U.S. Agency for International Development

Water use and management in Egyptian agriculture

are just beginning to assess their mineral bases. With significant amounts of copper, iron, gold, phosphate, zinc, lead, and some bauxite found in Saudi Arabia, some observers expect Saudi Arabia may become as important an exporter of minerals in the future as it is of oil today.[9] Important mineral resources now being extracted in other areas of the Middle East[10] include iron, phosphates, and, to lesser extent, copper, manganese, coal, and salt. Large deposits of titanium (an important structural metal element) were discovered in Egypt's Eastern Desert in 1971, and several observers have suggested that other large areas of the Egyptian and Arabian deserts that still have not been intensively surveyed may also prove to be rich in other minerals. In addition to hydrocarbons, Algeria has valuable uranium deposits in the Sahara as well as already exploited deposits of iron, coal, phosphates, zinc, and lead, and unexploited deposits of manganese, diamonds, iron, and platinum. At present, however, in the Middle East mining and production of minerals have not been developed to a great degree, and mineral exports comprise a very small proportion of Middle Eastern production and exports.

FINANCIAL RESOURCES

Oil and gas are the foundation of the financial resources of these Middle Eastern countries. High oil revenues have allowed the oil-rich countries of the Middle East to be freer of the balance-of-payments constraints found in most other parts of the developing world. But in those Middle Eastern countries with smaller reserves, such as in Egypt, financial constraints remain strong. During the current period of oil glut, moreover, the overall financial situation of all of these countries has changed.

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[9] Louis Turner and James M. Bedore, *Middle East Industrialisation* (Hants, England: Royal Institute of International Affairs, Saxon House, 1979), p. 3.

[10] See *Iran: A Country Study*, op. cit., pp. 310-311. In 1975, estimated reserves of some of Iran's more important mineral resources were: iron ore, 114 million tons (with a metal content of 35 to 62 percent); copper ore, 1 billion tons (much of it high grade); lead and zinc ore, 10 million tons; antimony ore, 12,000 tons; manganese ore, 720,000 tons; chromite, 7 million tons; and coal, 300 million tons.

The rapid influx of large amounts of capital into the Middle East dates mainly to the early 1970's. Large-scale capital flows resulting from the oil price rises in 1973 generated massive financial resources for the oil-producing countries. Nominal prices continued to increase well into the early 1980's, while oil production remained high. As table 3 indicates, the largest price increase occurred between 1973 and 1974, but between 1979 and 1980, another jump in prices occurred, with Saudi Arabian Light, for example, almost doubling from slightly over $13 to $26/barrel (or about $17 to $30 in 1982 prices).

While the large producers benefited most from this wealth, the effects were felt throughout the Middle East in: 1) private investment, public investment, and direct assistance by oil producing countries to other Middle Eastern countries; and 2) labor remittances to those countries poorly endowed with oil but which exported manpower to the labor-short, oil-rich nations. Large-scale capital flows into the Middle East, in turn, led to rising investments by oil-rich countries in the West and massive imports of goods and services from industrialized countries.

Circulation of oil revenues throughout the Middle East, however, did not greatly offset the growth of vast differences in financial resources among Middle Eastern countries. Table 4 and map 2 show improvement in the financial situations of selected Middle Eastern countries between 1970 and 1980. In 1981, Saudi Arabia's gross international reserves were reported as over $34 billion (U.S.)—more than 20 times those of Egypt. By 1982, Saudi

Table 3.—Crude Oil Selling Prices[a] (U.S. dollars per barrel, Jan. 1, 1984)

	1973	1974	1975	1976	1979	1980	1981	1982
Saudi Arabian	2.41	10.84	10.46	11.51	13.34	26.00	32.00	34.00
Light (34)	(4.72)	(19.52)	(19.15)	(18.02)	(16.29)	(30.23)	(34.04)	(34.00)
Algerian	3.30	14.00	12.00	12.85	14.81	30.00	40.00	37.00
Saharan (44)	(6.47)	(25.21)	(19.76)	(20.12)	(18.11)	(34.80)	(42.39)	(37.00)

[a] Figures are in nominal prices; numbers in parentheses are real prices in 1982 dollars.

SOURCE: Energy Information Administration, U.S. Department of Energy, *1981 International Energy Annual* (Washington, D.C.: U.S. Government Printing Office, 1983), p. 47. 1982 prices computed from given.

Table 4.—Balance of Payments and Financial Situation of Middle East Countries (million U.S. dollars)

	Current account balance (millions of dollars)		External public debt[a]		Gross international reserves	
	1970	1981	1970	1981	1970	1981
Egypt	−148	−2,135	1,644	13,887	165	1,683
Algeria	−125	249[b]	937	14,392	352	5,915
Iran	−507	—	2,193	—	217	17,205[c]
Iraq	105	—	274	—	472	—
Saudi Arabia	71	45,119	—	—	670	34,051
Kuwait	—	13,758	—	—	290	5,077

[a] Outstanding and disbursed.

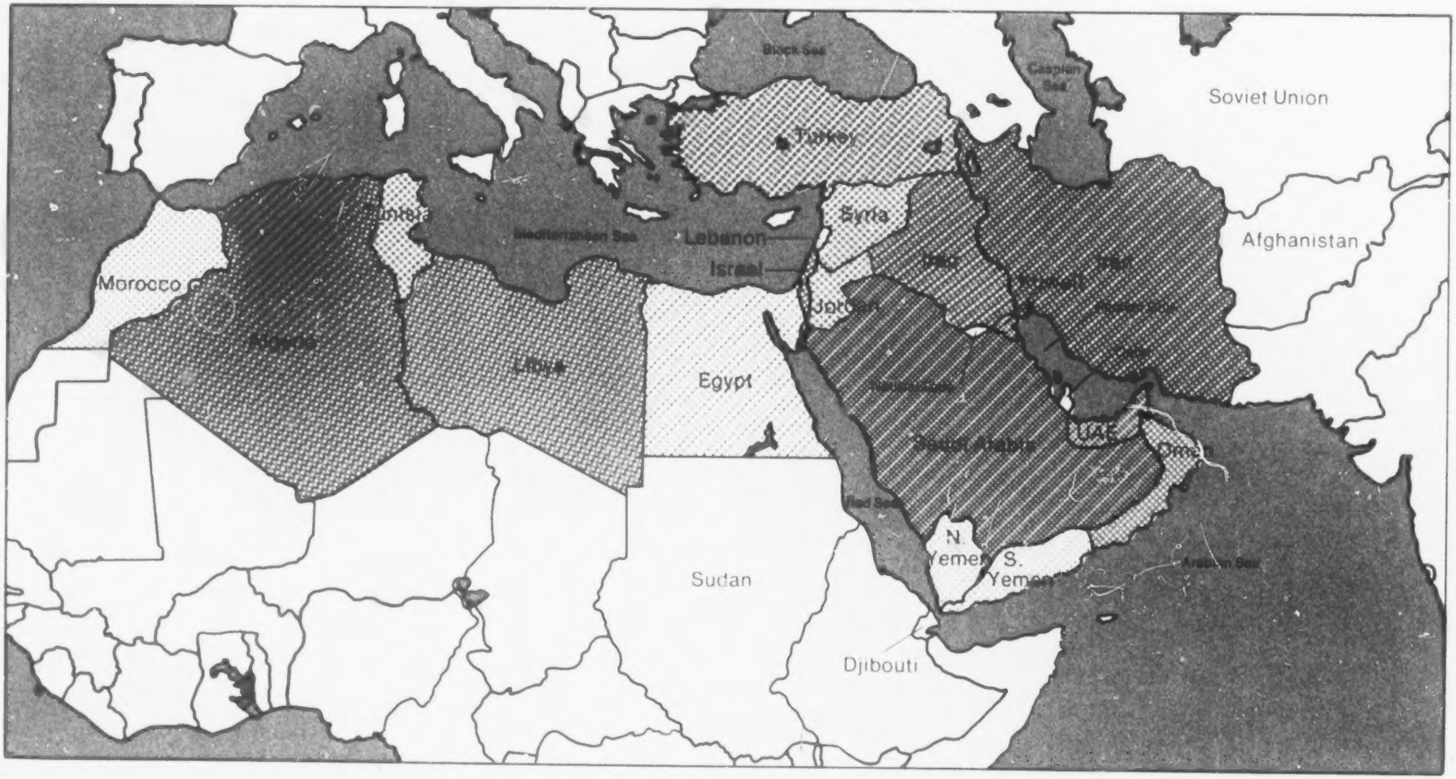
[b] 1980.

[c] 1979.

Note: Gross international reserves include holdings of gold, special drawing rights, the reserve position of International Monetary Fund members in the fund, and holdings of foreign exchange under the control of monetary authorities.

SOURCE: The World Bank, *World Development Report, 1983* (New York: Oxford University Press, 1983), pp. 174-175, 178-179.

Map 2.—Economic Activity in the Middle East



Key:

GNP per capita (1981, U.S. dollars)	Total GDP (1981, millions U.S. dollars)
☐ 1-1000	☐ 500-10,000
▨ 1001-2000	☐ 10,000-20,000
▨ 2001-10,000	☐ 20,000-35,000
▨ 10,000-25,000	☐ 35,000-60,000
	☐ More than 60,000

Note: Total GDP for Iran is for 1977, GNP per capita, for 1978. Total GDP for Iraq is for 1979, GNP per capita, 1980. Data for all countries is for 1981.

NOTE: The delineation of boundaries on this map must not be considered officially accepted. Geographic names or their spellings do not necessarily reflect recognition of the political status of an area.

SOURCES: Office of Technology Assessment; oil and gas reserves from U.S. Department of Energy, *1982 International Energy Annual* (Washington, D.C.: U.S. Government Printing Office, 1983), p. 80. Location of oil and gas fields from Michael Dempsey, *Atlas of the Arab World* (New York: Facts on File Publications, Nomad Publishers Ltd., 1983), p. 17.

Arabia and Kuwait claimed total official foreign assets of almost $199 billion—or more than those held by the industrial country bloc.[11] And today, in addition to oil revenues, both Saudi Arabia and Kuwait enjoy substantial investment income as well. Oil revenues to Kuwait, for example, declined during the first 3 years of the 1980's—falling from $19.5 billion in 1980, $13.6 billion in 1981, and a projected $8 billion to $9 billion in 1982. But this decline has been offset by Kuwait's rapidly growing foreign investment income, estimated at $6 billion in 1980, $8.2 billion in 1981, and $9.1 billion in 1982.[12]

Egypt, and to a lesser extent Algeria, on the other hand, have much more limited financial reserves. Egypt is in a more favorable position than most developing countries in that it not only has some petroleum for export, but also earns considerable foreign exchange from remittances to workers from foreign countries and companies. The bulk of Egyptian foreign exchange revenues has come not only from petroleum exports, but from three main services largely connected with petroleum: workers' remittances, tourism, and Suez Canal tolls.[13] But at least for the past decade, Egypt faced serious balance of payments and debt repayments problems. In 1981, therefore, Egypt's current account balance was a negative $2.1 billion (U.S.), as opposed to a positive $45.1 billion for Saudi Arabia. Gross international reserves for Egypt were only about $1.6 billion, as opposed to Saudi Arabia's $34.0 billion (see table 4). Indeed, Egypt's external public debt registered over $13 billion (U.S.), or more than half of its gross national product (GNP). Egypt's financial position has been supported by foreign aid, especially from the United States, with economic assistance in fiscal year 1981 reaching over $1 billion.

Algeria's financial resources are also more limited than those of the Gulf States. But while Algeria's external public debt is even higher than Egypt's, natural gas reserves have tended to mitigate reservations about Algeria's high foreign debt and the ability to repay it; Algeria has therefore been able to borrow more freely. In the mid-1970's, Algeria numbered among the world's most heavily indebted less developed countries (LDCs), both in absolute terms and on a per-capita basis. By 1981 Algeria's total estimated disbursed external debt was $17.5 billion, and the debt service was estimated at 25 percent of imports. But the easier access to foreign capital which Algeria has enjoyed relative to Egypt has allowed the Algerian Government to expand its investments and increase its volume of technology trade. Thus, while Algeria's external public debt in 1981 was even slightly higher than Egypt's (table 4), this represented a smaller proportion of Algeria's GNP, and Algeria's international reserves remained significantly higher than Egypt's. Limited capital availability, however, still remains a serious problem for Algeria.

Iraq and Iran represent a middle position. Both Iraq and Iran were important petroleum exporters before the outbreak of war, but since then their financial positions have changed dramatically. As the world's fourth largest producer and second largest exporter of petroleum in the mid-1970's, Iran's revenues from petroleum exports grew from $155 million in 1956 to a peak of $23.6 billion in 1977. Large oil revenues have also dominated Iraq's sources of foreign exchange since the early 1950's and have largely determined the level of imports. The Iran-Iraq War, however, has greatly eroded the generally favorable financial position of both countries. As income from sales dropped with export interruption and falling prices, and as expenditures for war-related consumption dramatically increased, the estimated $35 billion in Iraq's foreign currency reserve were drawn down. Capital availability in Iraq has become severely limited and Iraq has turned to external loans and grants. Iran, too, has encountered financial constraints that were unknown before the revolution and the outbreak of war with Iraq. Iran was able to export more oil than Iraq during the 1982-84 period, while Iraq reportedly received considerable Arab aid.

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[11] See Ragaei El-Mallakh, "U.S. Economic Ties With the Arab States of the Gulf and Egypt," *The Middle East in the 1980's: Problems and Prospects* (Washington, D.C.: The Middle East Institute, 1983), pp. 17-32. For estimates of total foreign assets, see George T. Abed, "Arab Financial Resources: An Analysis and Critique of Development Policies," in *Arab Resources*, Ibrahim Ibrahim (ed.) (Washington, D.C.: Center for Contemporary Arab Studies, 1983), pp. 43-70.

[12] "Kuwait Economic Trends," American Embassy, Kuwait, October 1982, p. 3. Figures for 1982 were preliminary estimates. Investment income for Saudi Arabia was estimated at 35 billion Saudi riyals in 1982-83 (or about $10.2 billion at a 1982 exchange rate of 3.44 Saudi riyals = $1 U.S.). See ibid., p. 21.

[13] In 1981, exports of petroleum and petroleum products comprised a total of 2820 million Egytian pounds (L.E.), out of a total export revenue of 4,040 million pounds; cotton, the second largest Egyptian export, brought a total of only 310 million L.E. in export revenue. And out of a total of 4,920 million Egyptian pounds in services receipts, approximately 590 were from tourism, 888 from Suez canal revenues and an estimated 2,200 million from workers remittances. "Economic Trends Report: Egypt," op. cit., p. 1. (At the end of 1981 1 Egyptian pound = $1.23 U.S.)

Prospects for financial resource availability in the Middle East are difficult to assess. Because of their reliance on exports of oil and external sources of income (e.g., remittances and foreign aid in the case of Egypt), Middle Eastern countries will remain sensitive to their international environment, including changes in the oil market and regional politics. Most projections suggest that the oil-exporting countries will probably have to adapt to a lower level of income growth in the coming years than in the decade of the 1970's. Opinions differ mainly as to just how much adaptation this adjustment will require.[14]

One view suggests that if oil prices do not rise dramatically, financial constraints may become an important issue, even in the capital-rich states. Along these lines, one estimate projects that the price of oil, which declined in 1983, will rise moderately after 1984.[15] These projections portend only a partial recovery in revenues in the following few years of the 1980's. In real terms, this report suggests that by 1986, nominal government oil revenues will be about 94 percent, and their purchasing power only about 74 percent, of 1981 levels.

On the other hand, other observers have noted that at least for the capital-rich states, even if revenues decline substantially in the coming years, this will not necessarily lead to more severe capital constraints in the oil-rich nations. This is attributed to these countries' limited absorptive capacity, and the flexibility and diversity of capital-rich states in their sources of revenue.[16] Indeed, these observers note, despite budgetary cutbacks in certain sectors, the total 1984 Saudi budget was larger than that for 1982. These issues are discussed in chapter 14.

ECONOMIC STRUCTURE

The countries of the Middle East can be divided between the traditionally agricultural and the overwhelmingly oil-based economies. Despite some diversification during the 1970's, this division still holds.

Figure 8 illustrates this dualism in economic structures in the Middle East, with Egypt at one extreme, and the oil-based economies, mainly Saudi Arabia and Kuwait, at the other.

Prior to the 1970's, few of the countries under review had a well developed industrial or manufacturing base, although their levels of industrial production differed. In Saudi Arabia in 1973, for example, there were four refineries, a fertilizer plant, and a small operation for producing iron and steel products for the building industry.[17] Saudi Arabia had virtually no experience with industrialization, aside from that which the Arabian American Oil Company (ARAMCO) had fostered, and data suggest that under 5 percent of the employed population was engaged in manufacturing activities in the mid-1960's. Iran was at the other end of the scale. With a larger, more skilled population and initial discoveries of oil more than 30 years earlier than in Saudi Arabia, Iran's industrial development was at

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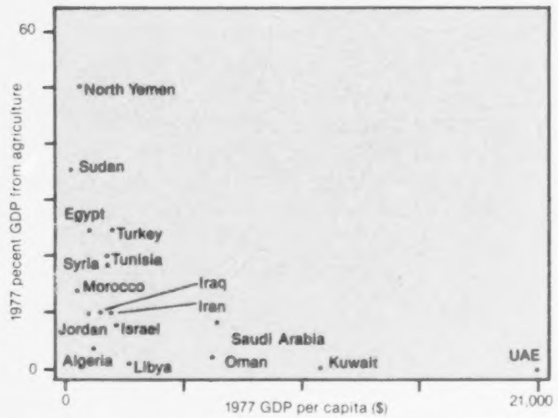
[14] See, for example, Joseph C. Story and Vahan Zanoyan, "Economic Outlook for the Middle East and North Africa," *Middle East Economic Digest,* June 3, 1983, pp. 39-47.

[15] According to Storey and Zanoyan, by 1985, Kuwait, along with some of the other smaller Gulf States is projected to be producing either at almost full capacity or at the production ceilings they had before the oil glut began. Saudi Arabian output is projected to grow at a more moderate rate at an average 4.9 b/d in 1983, 6.15 million b/d in 1984 and to remain between 7.2 million to 7.8 million b/d in subsequent years, ibid., pp. 38-39.

[16] See, for example, El-Mallakh, op. cit.

[17] See, for example, Turner and Bedore, op. cit., p. 4.

Figure 8.—Percent of GDP From Agriculture Compared to GDP Per Capita, 1977



Note: The IMF and the World Bank do not report national accounts statistics for Bahrain, Lebanon, Qatar, and South Yemen. They are not included on this figure. Data for Iraq, North Yemen, and Kuwait are from 1976. Sectoral origin of GDP is computed at constant factor costs for all countries except Jordan, Israel, and the UAE, which are at current factor costs.

SOURCES: International Monetary Fund, *International Financial Statistics Yearbook*, 1982; The World Bank, *World Tables*, 2d ed., 1980; and data on sectoral origin of GDP for Egypt, Jordan, and the United Arab Emirates are from the United Nations, *Yearbook of National Accounts Statistics*, 1980.

a more advanced stage. Nonetheless, until the 1970's, industry was poorly developed in most of the countries under review.

During the 1970's, growth in revenues stimulated changes in economic growth and structure. In the countries under review, GDP grew rapidly throughout the 1970's, even in those countries with smaller petroleum reserves. The growth rate of GDP in Egypt prior to 1974 was a relatively poor 1 to 3 percent. Between 1975 and 1977, however, it averaged around 13 percent, before declining to an average of 8 to 10 percent annually through mid-1981. These high rates of growth greatly offset population growth rates, and per-capita income also rose rapidly. In Algeria per-capita income in 1976 was estimated as between $780 and $1,000, lower than that of the larger oil producers but substantially higher than that of neighboring countries such as Morocco and Tunisia.

Table 5 illustrates the changes in the sectoral structure of GDP in selected Middle Eastern countries. The Middle East has been characterized by an almost uniform decline in the contribution of agriculture to GDP and continued importance of hydrocarbons to the growth of the GDP. One of the largest declines in agriculture occurred in Iran, where agriculture's contribution to the GDP declined from 29 to 9 percent between 1960 and 1977. Between 1960 and 1981, agriculture's contribution to the GDP declined from 30 to 21 percent in Egypt and 17 to 7 percent in Iraq; in Algeria, agriculture's contribution to the GDP was reportedly around 6 percent in 1981.

At the same time, the proportion of the hydrocarbon sector in the GDP grew rapidly in the more agricultural countries, and remained high in the oil-rich countries. The proportion of hydrocarbons in Algeria's GDP grew from about 15 percent in the late 1960's to about

Table 5.—Distribution of GDP by Sector, 1981

	GDP ($ billion)	Agriculture (%)	Industry (%)	Manufacturing (%)	Services (%)
Kuwait	24.3	(.)	71	4	29
Saudi Arabia[a]	115.4	1	78	4	20
Iran[c]	(69.2)	(9)	(54)	(12)	(37)
Iraq[b]	30.7	8	73	6	19
Algeria	41.8	6	55	11	39
Egypt	23.1	21	38	32	41
Developing country averages					
Middle-income economies	NA	14	38	22	48
Low-income economies	NA	37	34	16	29

NA = not available

[a] Data for 1980.

[b] 1979, *World Development Report*, 1981, p. 139.

[c] Data for 1977, in parentheses, from World Bank.

Note: Manufacturing is a part of the industrial sector.

SOURCE: The World Bank, *World Development Report, 1983* (New York: Oxford University Press, 1983), pp. 152-3.

30 percent in 1979. In Egypt, from a negligible contribution to GDP of 1 to 2 percent at the beginning of the decade, the petroleum sector grew to over 13 percent of the GDP in 1979, 22 percent in 1980, and 20 percent in 1981.[16] Today, in the oil-rich countries of Saudi Arabia and Kuwait, GDP is still heavily oil-centered. Egypt remains on the other end of the scale, with a nonoil GDP still at a relatively high 80 percent of the total GDP. Iran, Iraq, and Algeria again fall in between.

Declines in agriculture have not been accompanied by a rise of manufacturing with like strength. Especially for the heavily oil-centered economies, manufacturing remains a very small contributor to GDP, registering only about 4 percent of GDP in 1981. In Iran and Algeria, the proportion of manufacturing has been somewhat higher (about 11 percent), but still below the average for both low- and middle-income countries worldwide. Instead, the oil-rich countries of the Middle East have been highly service-oriented: the ratio of services to manufacturing output is 2.5 to 3.5 times higher in Saudi Arabia and Kuwait than the average for low- and middle-income countries worldwide; and while somewhat lower in Iran, Algeria, and Iraq, it is well above the world average. In Egypt, on the other hand, manufacturing contributed 32 percent to GDP in 1981, and the ratio of services to manufacturing output was well below the world average.

There are also striking differences between the oil-rich states and the middle-income oil exporters in volume of exports. The export share of GDP is highest in the oil-rich states, reaching as high as 74, 72, and 63 percent in the UAE, Kuwait, and Saudi Arabia, respectively. Two Middle Eastern countries stand out in this context, Algeria (33 percent) and Jordan (51 percent). These data indicate diversification in Algeria's economy but in the case of Jordan the important fact not revealed in the data is substantial exports despite the absence of oil.

IMPLICATIONS FOR TECHNOLOGY TRANSFER

This context provides both opportunities and constraints for technology transfer. On the one hand, the oil-rich countries have substantial revenues, on a scale rarely found in other LDCs, allowing for enormous purchasing power for imports of advanced technology.

Especially for the oil-rich countries, however, the heavy reliance on petroleum for both revenue and economic growth also imposes constraints on technology transfer. The price of oil has been subject to unpredictable fluctuations so large as to have strong effects on Middle Eastern economies. With continuing uncertainty surrounding the price of oil, capital constraints could become more severe, even for the oil-rich countries.

Another implication for technology transfer stems from economic structure. Oil-centered economies such as the Gulf States aim to develop other economic sectors, but may face constraints in such diversification due to limitations in other natural resources. The oil-rich countries, facing uncertainty in the magnitude of future earnings, must work to increase productivity in their economies and to expand manufacturing. In contrast, countries such as Egypt less well endowed with petroleum have a somewhat more diversified resource and economic base but face severe financial constraints.

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[16] Figures for Algeria taken from U.S. Department of Commerce, *Foreign Economic Trends and Their Implications for the United States: Algeria*, July 1981, p. 2. Figures for Egypt, from U.S. Department of Commerce, *Foreign Economic Trends and Their Implications for the United States: Egypt*, May 1982, p. 10. Figures for oil and nonoil GDP for the remaining countries in OTA's study vary widely. One of the more conservative estimates suggests that in 1980, petroleum accounted for about 70 percent of the total GDP in Saudi Arabia, 59 percent in Kuwait, 52 percent in Iraq, and about 22 percent in Iran, although other estimates suggest the proportion may be much higher. These estimates are computed from Wharton Econometric Associates, *Middle East Economic Outlook*, vol. 3, No. 1 (Washington, D.C., April 1983), computer printout appendixes to each country section.

MANPOWER

Technology absorption requires not only financial resources, but also a skilled scientific and technical manpower base. Most Middle Eastern countries face shortages of manpower skilled in scientific and technical areas. This is especially the case for the oil-rich countries, while Egypt is among the countries best endowed with large and skilled population resources. The following section assesses the manpower resources of the countries under review, the role migration has played in addressing imbalances among them, and the context this situation provides for technology transfer.

LABOR FORCE

As illustrated in map 3 and table 6, differences in total population among the countries under review are substantial. Estimates of total population in 1981 ranged from 1.5 million for Kuwait and approximately 7 million to 9.5 million for Saudi Arabia, to populations of close to 40 million in Egypt and Iran. Because of differences in land size and terrain, population density varies considerably. Egypt's territory, less than half the size of Saudi Arabia, hosts a population upwards of five times that of Saudi Arabia. And since Egypt's population is heavily concentrated in approximately 5 percent of its total territory, the disparity in population density is even greater.[19]

The size of the labor force also varies greatly in the six countries under review. Approximately one-half the total population of these countries in 1979 was of working age (15 to 64 years old); in Egypt, the proportion was slightly higher, 57 percent. The size of the labor force is estimated to range from about 1.8 million people in Saudi Arabia to over 10 million people in Egypt.

Especially during the past decade, all of the Middle Eastern countries under review have seen rapid growth and structural diversification of the labor force; yet today, all are experiencing shortages of skilled professional and technical manpower necessary to meet the demands associated with rapid economic development and technology transfer from abroad. Matching changes in economic structure discussed earlier, the proportion of the labor force engaged in agriculture has declined over the past two decades.[20] This decline in agriculture, moreover, has been matched by a growth in the proportion of the labor forces employed in manufacturing, construction, services, and industry, and in the number of managerial and administrative personnel, professional and technical workers, and industrial production workers. Nonetheless, throughout the Middle East, agriculture and pastoralism are still the main employers of the population, while professional and technical workers comprise but a small share of the total work force in these countries. (See fig. 9.)

In general, there is a sharp division between the traditionally labor-importing and labor-exporting countries. Saudi Arabia and Kuwait have indigenous populations and labor forces that are relatively small, less technically skilled, and heavily concentrated in the service sectors. On the other end of the scale are the labor-exporting countries such as Egypt, with larger populations and a more skilled and diversified manpower base, but which have experienced high underemployment and unemployment rates.

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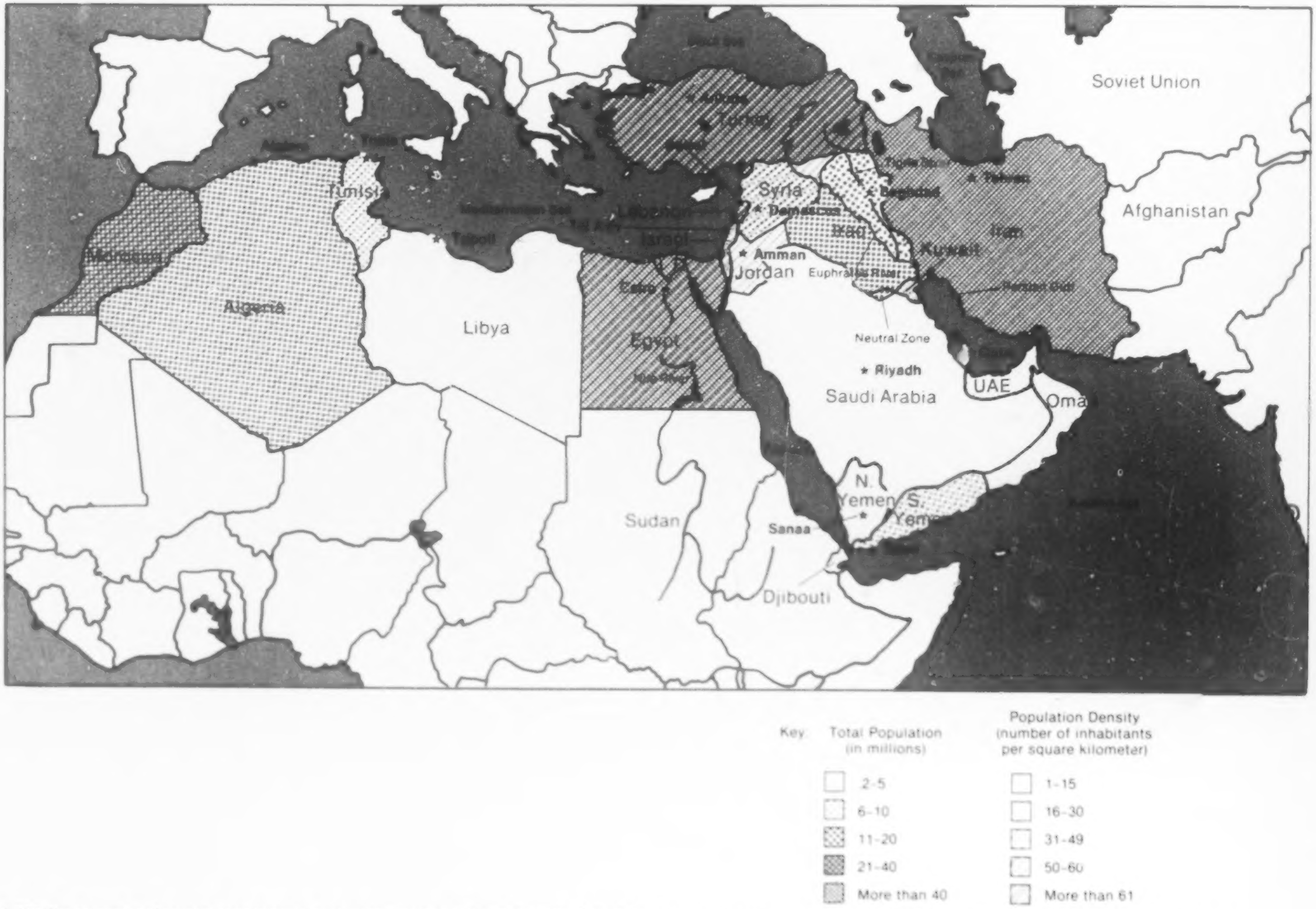
[19] Estimates of the total population of Saudi Arabia vary widely from 7 million to 9.5 million people, for 1980. A plausible midrange estimate is 7.7 million. Between 1970-77, most of the countries under review had population growth rates of between 3.1 and 4.0 percent per year. Egypt, with an annual population growth rate of 2.1 percent, was the exception on the low end, as was Kuwait, at 6.0 percent per year, on the high end. Indeed, 98 percent of Egypt's population lives in the Nile Valley, where population density may reach as high as 2,300 persons per square mile. See J. S. Birks and C. Sinclair, *Arab Manpower: The Crises of Development* (London: Croom Helm, 1980), p. 215.

[20] See The World Bank, *World Development Report 1983* (New York: Oxford University Press, 1983), pp. 188-189, 147. As illustrated in fig. 9, the agricultural labor force decline may have been even greater, as indicated by the International Labour Organization, which reported an even lower proportion of the labor force in agriculture in 1977.

Map 3.—Population Size and Density in the Middle East



NOTE: The delineation of boundaries on this map must not be considered officially accepted. Geographic names or their spellings do not necessarily reflect recognition of the political status of an area.

SOURCE: Office of Technology Assessment compiled from the World Bank *World Bank Development Report 1983* (New York: Oxford University Press, 1983), pp. 148-9. Data for Oman from Agency for International Development *Near East Bureau Strategy 1983-1988* Revised, December 1983, p. 16. Data for Qatar from Michael Dempsey, *Atlas of the Arab World* (New York: Facts on File Publications, 1983).

Table 6.—Basic Indicators, Selected Middle East Countries, 1981

	Population (millions) (mid-1981)	Area (1,000 km²)	Average annual population growth (1970-81)	Adult literacy[a] (%, 1980)	Urban population as percent of total population (1981)
Saudi Arabia	9.3[b]	2,150	4.5	25	68
Kuwait	1.5	18	6.3	60	89
Iran	40.1	1,648	3.1	50	51
Iraq	13.5	435	3.4	NA	72
Algeria	19.6	2,382	3.3	35	44
Egypt	43.3	1,001	2.5	44	44
Average middle-income economies	NA	NA	2.4	65	45

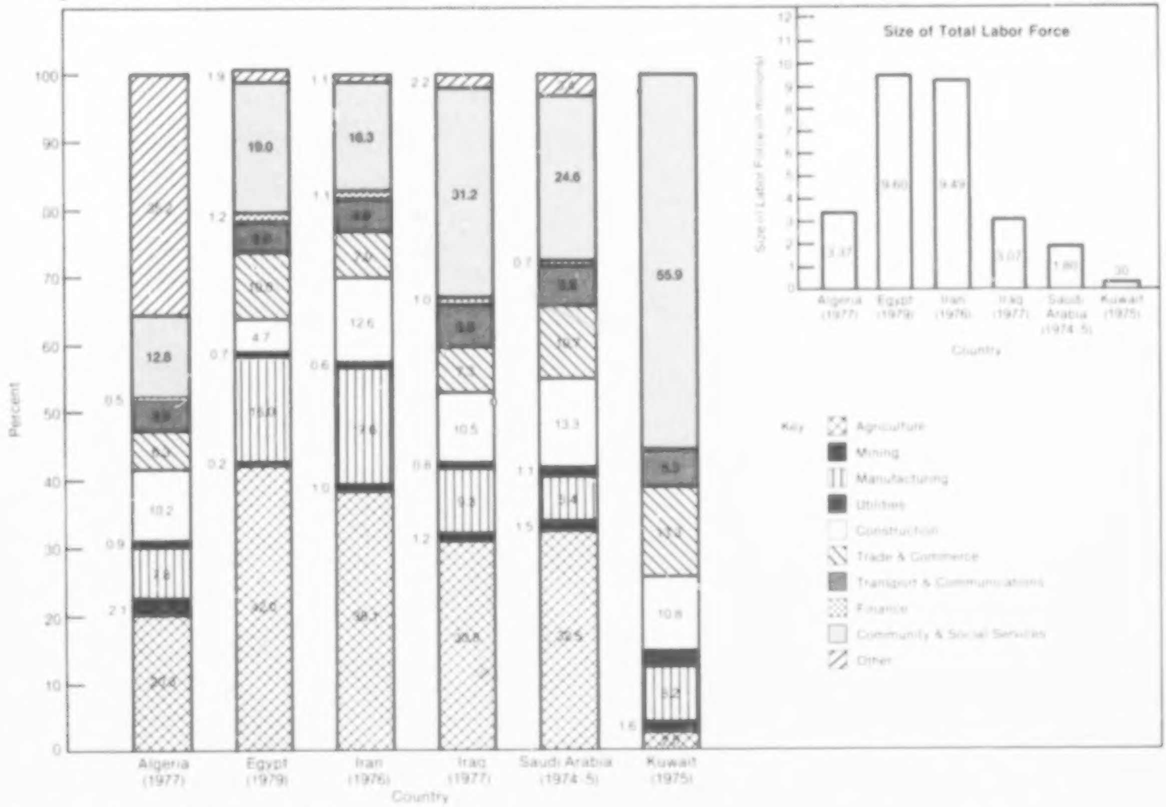
NA = not available.

[a] Adult literacy represents the percentage of persons aged 15 and over who can read and write. Data for Iran, Algeria, and Egypt are for years other than 1980 but not more than 2 years distant from the other estimates.

[b] As illustrated in the text of this report, this is among the higher estimates for the total population of Saudi Arabia, which range between about 7 million and 9.5 million. The estimate here is used to retain consistency of sources.

SOURCE: The World Bank, *World Development Report, 1983* (New York: Oxford University Press, 1983), pp. 148-9, 184-5, 190-1.

Figure 9.—Structure of Economically Active Population in Selected Middle East Countries, (in percent)



Note: Included indigenous and non-indigenous labor force.

SOURCE: Office of Technology Assessment. Computed from International Labor Organization, *Yearbook of Labor Statistics*, 1981 and J.S. Birks and C.A. Sinclair, *Arab Manpower* (London: Croom Helm, 1980) pp. 45-108.

Many occupational categories are important for technology transfer, among them trained scientists and engineers. Their contribution as managers of projects, in particular, is important. Table 7 shows the number of trained scientists and engineers in these countries in the 1970s. Egypt and Kuwait are at opposite ends of the scale, although scientists and engineers comprise a relatively high proportion of Kuwait's total labor force.

Expansion in education suggests that the availability of scientists and engineers will improve, but that disparities among countries may remain wide. In all of the countries under review, educational enrollments have grown rapidly compared to those of other middle-income countries. Between 1960 and 1980, as table 8 shows, the proportion of the age group enrolled in secondary school more than doubled—and in some cases more than tripled. By 1980, it had reached as high as 75 percent in Kuwait, 57 percent in Iraq, and 52 percent in Egypt, compared to the average weighted growth for middle-income countries in general of 39 percent. Educational training has been extensive in Egypt, while in the labor-short countries under review, the numbers and percents of school enrollments are still low. In 1980, 15 percent of Egypt's population aged 20 to 24 was enrolled in higher educational establishments, as opposed to half that amount in Saudi Arabia. Generally speaking, the availability of indigenous scientific and technical manpower can be expected to increase as a result of these efforts.

Today the disparity among countries is, however, especially pronounced in the vocational and technical fields. In Egypt, almost one-fifth of all students enrolled in secondary or higher level schools in 1976-77 were in vocational and technical schools. The proportion was considerably lower than this in all of the other countries under review, especially in Algeria. While some of this difference may be accounted for by the different structure of technical training in the countries under review (see ch. 11), these data indicate shortfalls from country plans and perceived requirements. In Algeria, the National Development Plan anticipated a need for 80,000 highly skilled and 180,000 medium-skilled personnel by 1984; 50,000 people of the latter group were to be in technical, scientific, and production areas. In 1978, however, less than 2,000 degrees were awarded in Algeria in scientific and technological fields; as of 1980, higher educational enrollment was 67,000 students, but only 27 percent were in the scientific and technical fields.

Table 7.—Number of Trained Scientists and Engineers, 1970's

Country	Total
Kuwait (1975)	27,246
Algeria	NA
Egypt (1973)	593,254
Saudi Arabia (1974)	33,376[a]
Iran (1974)	161,183
Iraq (1972)	43,645[a]

[a]Estimated; data for Iraq include persons in government institutions only.
Note: Current data are not available.

SOURCE: UNESCO, *Statistical Yearbook, 1981* (London: Computaprint, Ltd., 1981), pp. V. 23-5.

FOREIGN MANPOWER

The disparities in the size and quality of manpower resources have led to high levels of migration in the Middle East, both within the region itself and from without. This migration of labor is a relatively recent phenomenon. Until the early 1970's, the Islamic Middle East was conventionally viewed as a closed labor market, with little inflow or outflow of population. The oil price increases of 1973, however, led to an exploding demand for labor in the newly rich oil-exporting countries. Wages increased, employment opportunities grew, and labor from other countries responded rationally—i.e., by moving from low-wage areas to those of higher wages. Once a relatively contained region with little migratory movement of labor (aside from the migration of workers from Algeria to France and the resettling of many West Europeans in Israel), the Middle East became a region of dynamic and massive labor migration. The migration involved both skilled and unskilled labor, and entailed movement both among the Middle Eastern countries and from almost all other regions of the world.

Table 8.—Educational Enrollments in Selected Middle Eastern Countries

	Number enrolled in primary school, as percent of age group[a]		Number enrolled in secondary school, as percent of age group[b]		Number enrolled in higher educational establishments, as percent of population aged 20 to 24		Number enrolled in vocational and technical schools, 1977-78	
	1960	1980	1960	1980	1960	1980	Total number	As percent of students enrolled in secondary levels or above[c]
Kuwait	117	96	37	75	NA	12	2,084	4.6
Algeria	46	95	8	33	(.)	5	11,798	1.6
Egypt	66	76	16	52	5	15	403,541[d]	18.0[d]
Saudi Arabia	12	64	2	30	(.)	7	5,169	5.9
Iran	41	101	12	44	1	5	NA	NA
Iraq	65	116	19	57	2	9	28,365[d]	4.7
Average, middle-income economies, 1960-80	75	100	14	39	3	11	NA	NA

[a] Primary school age is generally considered to be 6 to 11 years old, but may vary by country. In some countries, enrollment ratios may exceed 100 percent, owing to some pupils being above or below the official primary school age.

[b] Secondary school age is generally considered to be 12 to 17 years old.

[c] "Secondary levels or above" includes preparatory schools following primary certification, secondary schools, and all higher institutions.

[d] 1976-77.

NA = not available.

SOURCES: Cols. 1-6: The World Bank, *World Development Report, 1983* (New York: Oxford University Press, 1983), pp. 196-197.
Cols. 7-8: Paul Shaw, *Mobilizing Human Resources in Arab World* (London: Kegan Paul International, 1983), p. 169.

During the 1970's, therefore, the pattern of labor movement in the Middle East became highly complex, affecting employment in all economic sectors. Algeria continued to export unskilled labor mainly to France while importing skilled labor from other countries in the Middle East. The oil-rich countries became importers of all skills in greater numbers, while Egypt became a major exporter of all skills.[21] The Sudan and the Yemens continued to export unskilled labor. And some countries, such as Iraq, began to both import and export labor simultaneously.

As the demand for manpower rose, the numbers of migrants in the Middle East grew, so that by the mid-1970's, one-fourth of North Yemen's labor force and almost one-third of Jordan's was employed in other countries of the Arab world,[22] while close to three-fourths of Kuwait's labor force was comprised of foreign personnel. Table 9 illustrates one set of estimates of the magnitude of migrant workers in the Arab world in 1980. According to these data, the number of Egyptians working in other parts of the Arab world grew to almost 750,000 in 1980. Beginning in 1976, Asian labor—Pakistanis, Indians, Bangladeshis, Koreans, Baluchis, and others, or people from countries which traditionally had little contact with Arab economies—began to migrate to the Middle East as well. The number of Pakistanis and Indians working in the Middle East grew to more than 650,000 in 1980.[23] At the same time, the influx of personnel from Western countries also increased, mainly to work in highly skilled professional and technical positions.

Table 10 illustrates the sectoral distribution of foreign workers for two of the largest labor-importing countries in the Middle East, Saudi Arabia, and Kuwait as of the mid-1970s. Both Saudi Arabia and Kuwait have been particularly dependent on foreign workers in their manufacturing, construction, and commerce sectors. In Kuwait, the construction sector is nearly completely (95 percent) dominated by foreign workers, with about 90 percent of the manufacturing sector being comprised of foreigners as well. According to one estimate, Egyptians and Turks make up between 20 and 25 percent of Iraq's work force, a significant proportion of whom are in agriculture, services, and construction. In many Middle Eastern labor-importing countries, Asian labor—mainly Korean, Indian, and Pakistani—has dominated much of the construction sector, while Egyptian labor has dominated manufacturing and such services as education and medicine.

Foreign workers are generally concentrated in either the technical occupations or in the lowest skilled, manual occupations, while indigenous personnel are concentrated in either the managerial positions (often with foreign assistants or deputies) or in the service occupations outside of the production process. Table 11 illustrates the occupational distribution of the labor force in Kuwait. In Kuwait, Egyptians and Jordanians make up large percentages of the professional and technical workers. Kuwaitis make up a larger share of the managerial and clerical workers, with Jordanians being the major foreign group filling these jobs. In the second half of the 1970's Saudi Arabia likewise grew increasingly reliant on foreign labor in the managerial, professional and particularly the technical occupational groups.

Information on the number of migrant workers in Iran has been unavailable since the Iranian revolution. While there may have been upwards of 1 million foreign workers in Iran in 1977, there is little reason to believe that more than a fraction of these workers remains. Prerevolution patterns were that the unskilled

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[21] For a discussion of the development of engineering skills in particular in Egypt, and problems of utilizing skills most closely associated with technology transfer and industrial development, see Clement Henry Moore, *Images of Development: Egyptian Engineers in Search of Industry* (Cambridge, Mass.: MIT Press, 1980).

[22] Nazli Choucri, *Migration in the Middle East: Transformations, Policies and Processes*, Technology Adaptation Program, Massachusetts Institute of Technology, Cambridge, Mass., 1983, p. 3-4.

[23] According to another estimate, the number of Pakistanis alone working in the Middle East grew from less than 200,000 in 1975 to almost 1.25 million in 1979. See ibid., pp. 3-10, 3-11.

Table 9.—Migrant Workers in the Arab World by Country of Origin and Employment, 1980

Country of origin	Country of employment										
	Saudi Arabia	Libya	United Arab Emirates	Kuwait	Qatar	Bahrain	Jordan (East Bank)	Oman	(YAR) Yemen	Iraq	Total
Egypt	155,000	250,000	18,000	85,000	6,000	3,000	69,000	4,000	4,000	150,000	744,000
Yemen (YAR)	325,000	—	5,000	3,000	2,000	1,000	—	—	—	—	336,000
Jordan/Palestine	140,000	15,000	19,000	54,000	8,000	2,000	—	2,000	2,000	10,000	252,000
Yemen (PDRY)	65,000	—	7,000	10,000	2,000	1,000	—	—	—	—	85,000
Syria	25,000	15,000	6,000	35,000	1,000	—	—	—	1,000	5,000	88,000
Lebanon	33,000	6,000	7,000	8,000	1,000	—	—	1,000	1,000	5,000	62,000
Sudan	56,000	33,000	2,000	6,000	1,000	1,000	—	2,000	1,000	—	90,000
Maghreb	1,000	65,000	—	—	—	—	—	—	—	—	66,000
Oman	10,000	—	19,000	2,000	2,000	1,000	—	—	—	—	34,000
Iraq	3,000	—	1,000	40,000	—	—	—	—	—	—	44,000
Somalia	8,000	5,000	5,000	1,000	—	—	—	—	—	—	20,000
All Arab	821,000	377,000	89,000	244,000	23,000	9,000	69,000	9,000	10,000	170,000	1,821,000
Pakistan	30,000	64,000	137,000	34,000	21,000	26,000	4,000	31,000	3,000	8,000	359,000
India	29,000	26,000	110,000	45,000	12,000	12,000	—	81,000	2,000	2,000	319,000
Other Asian	94,000	27,000	21,000	10,000	5,000	11,000	1,000	13,000	—	4,000	186,000
All Asian	153,000	118,000	268,000	89,000	38,000	49,000	5,000	125,000	5,000	14,000	864,000
OECD and Eastern Europe	30,000	15,000	12,000	5,000	1,000	6,000	2,000	5,000	1,000	3,000	80,000
Africa and other	6,000	10,000	1,000	1,000	1,000	1,000	—	1,000	1,000	3,000	25,000
Turkey	2,000	26,000	—	1,000	—	—	—	—	—	2,000	31,000
Iran	11,000		41,000	39,000	18,000	3,000	—	—	—	—	112,000
Grand total	1,023,000	546,000	411,000	379,000	81,000	68,000	76,000	140,000	17,000	192,000	2,933,000

SOURCE: J. S. Burks, I. Serageldin, C. A. Sinclair, and J. A. Socknat, "Who Is Migrating Where? An Overview of International Labor Migration in the Arab World," paper prepared for the World Bank, June 1981, p. 20.

Table 10.—Employment by Nationality and Economic Sector, Saudi Arabia and Kuwait, 1975

Sector	Total employment		Nationals as percent of total		Percent distribution of nationals		Distribution of nonnationals	
	Saudi Arabia	Kuwait	Saudi Arabia	Kuwait	Saudi Arabia	Kuwait	Saudi Arabia	Kuwait
Agriculture	585,550	7,514	90.6	53.1	51.7	4.6	7.1	1.7
Mining	27,000	4,859	57.0	36.6	1.5	2.0	1.5	1.5
Manufacturing	115,900	24,467	18.6	9.4	2.1	2.6	12.2	10.5
Construction	239,300	32,256	15.0	5.5	0.7	2.0	1.7	14.4
Utilities[a]	20,350	7,271	35.4	28.0	3.5	2.3	26.3	2.5
Trade	192,100	39,559	31.5	16.0	5.9	7.3	17.0	15.7
Transport and communications	103,800	15,685	70.2	29.2	7.1	5.2	4.0	5.3
Community and personal services[b]	455,150	166,802	54.1	38.6	24.0	73.9	27.0	48.5
Not defined	60,650	2	59.1	—	3.5	—	3.2	—
Total	1,799,800	298,515	57.0	29.2	100[c]	100[c]	100[c]	100[c]

[a] Electricity, gas, and water.
[b] Includes financing.
[c] Numbers may not equal 100 due to rounding.

SOURCE: Computed from J. S. Birks and Clive Sinclair, *Arab Manpower: The Crisis of Development* (London: Croom Helm, 1980), pp. 45, 108.

Table 11.—Employment by Nationality and Occupational Groups, Kuwait, 1975

	Professional technical workers	Managers	Clerical and related workers	Sales workers	Service workers	Agricultural workers	Production and related workers	Total work force
Total	41,836	2,854	38,018	24,093	78,300	7,702	105,608	298,415[a]
Kuwaiti	9,739	1,045	17,853	6,185	32,900	3,897	15,348	86,971
Non-Kuwaiti	32,097	1,809	20,165	17,908	45,400	3,805	90,260	211,444
Of which other Arabs	27,147	1,286	16,043	12,282	28,576	3,244	58,140	146,718
Of which Egyptians	11,061	241	2,359	740	8,338	436	14,383	37,558
Of which Jordanians and Palistinians	12,052	562	8,327	3,795	4,086	893	17,938	47,653
Iranians	246	23	384	3,394	4,308	464	20,114	28,933
Pakistanis	730	68	762	380	1,781	61	7,256	11,038
Indians	2,602	177	2,672	1,729	10,546	9	3,740	21,475
Other Asians	194	41	53	43	76	—	733	1,140
United Kingdom	586	82	133	29	40	2	88	960
France	48	16	12	1	3	2	13	95
Other Europeans	336	64	57	18	24	11	128	638
Americans[b]	176	45	25	7	1	1	15	270

[a] Total includes four persons in the category "not stated."
[b] Includes "USA" and "other Americans."

SOURCE: Calculated from Kuwait Ministry of Planning, *Annual Statistical Abstract, 1981*, Edition XVIII (Kuwait: Central Statistical Office, 1981), pp. 108-114.

workers came from Afghanistan, while the skilled workers came from the Far East.

For many of the labor-exporting countries, on the other hand, large-scale out-migration of technical and professional manpower has led to shortages in these skills at home. Due to out-migration of skilled personnel, Egypt, traditionally a "labor surplus" country, has experienced labor shortages in many of the skilled occupations, such as administrators, teachers, and clerks, of which Egypt continues to be a major supplier to other Arab countries.[24] Algeria today exports over 15 percent of its labor force. The bulk of Algerian migrants go to Europe, particularly to France, where these migrants work mainly as laborers and semiskilled workers, primarily in the heavy industries and construction.

Projections concerning migrationary movements and changes in Middle Eastern labor resources are uncertain. With the decline in oil prices and shifts in development plans and policies (discussed in ch. 11), some observers have already noted an apparent stabilization, if not decline, in the magnitude of migration to and within the Middle East. Iraq is one of the only exceptions: owing to the drain on its labor force caused by the war with Iran, Egyptians and other foreigners have been recruited to move there in greater numbers.

Labor issues in the 1980's will be determined not only by magnitude of demand, but by its structure and composition. A World Bank study predicted that the oil-rich nations' manpower requirements will rise sharply in the next few years especially in manufacturing.[25] This study, carried out in the late 1970's, estimated that demand will be greatest in the "technician" category and in the professional and technical occupations.

It is difficult to predict whether increased education and training at home will be sufficient to meet these demands, and to what extent demand will have to be met with foreign manpower. But for the labor-importing countries, most projections indicate that the demand in the technical and professional sectors may be met largely by foreign workers. The same World Bank study estimated that by 1985, between two-thirds and three-fourths of the manpower requirements of the oil-rich nations, in four out of the top five occupational levels will be filled by foreigners.[26]

The impacts of the recent decline in oil prices on migration, however, remain to be seen. If economic growth rates remain high, labor requirements will grow as well. But if further retrenchment in economic activity should occur, the need for foreign labor will decline. Large layoffs of foreign workers in Saudi Arabia's petroleum industry, especially in the Eastern province, for example, and Kuwait's decision in 1983 to send many Asian workers home are cases in point.[27] But there is no way of judging now whether a large-scale exodus of other types of foreign labor will occur.

IMPLICATIONS FOR TECHNOLOGY TRANSFER

Implications of the manpower situation for technology transfer are difficult to assess. For the labor-importing countries, for example, it is unclear at what point the dependence on foreign labor becomes a problem. Foreign workers can provide enormous economic benefits for recipient countries, aiding technology transfer by filling jobs for which the appropriate skills cannot be found among indigenous personnel. But if one aim of technology transfer is to maximize technology absorption among the indigenous personnel, then the continued presence of foreign workers may highlight a bottleneck in the technology transfer process. What is clear, however, is that the labor-importing countries of the Middle East remain heavily dependent on foreign labor in sectors and occupations critical for technology transfer, and levels of training in the technical fields suggest that this situation may not significantly change for some time.

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[24] Emigration of workers, for example, has allegedly created bottlenecks in Egypt particularly in the construction and petroleum sectors. See, for example, Saad Eddin Ibrahim, "Oil, Migration and the New Arab Social Order," *Rich and Poor States in the Middle East* Malcolm H. Kerr and El Sayed Yassin (eds.) (Boulder, Colo.: Westview Press, 1982), pp. 38-44.

[25] See Ismail Serageldin and James Socknat, "Migration and Manpower Needs in the Middle East and North Africa, 1975-85," *Finance and Development*, vol. 17, No. 4, December 1980, pp. 35-36. Note, however, that the study was carried out prior to the period of lower oil exports in the early 1980's when many foreign workers were sent home from the Gulf States.

[26] Professional and technical personnel, other professional personnel, technicians, and skilled office and manual personnel requirements were expected to be filled largely by foreigners; only "other subprofessional" occupations were projected to be staffed largely with nationals. See ibid., p. 35.

[27] See, for example, "Kingdom Restricts Foreign Work Force," *Middle East*, vol. 2, No. 4, Mar. 20, 1983, p. 3.

The manpower context for technology transfer in the labor-exporting countries is two-sided. On the one hand, the export of skilled labor provides remittances, providing countries such as Egypt with substantial revenue and thus enhanced purchasing power for advanced technology from abroad. Some have also argued that job vacancies created in Egypt by out-migration could stimulate upward mobility among those who stay behind.[28] On the other hand, the loss of highly skilled manpower in many labor-exporting countries has exacerbated problems at home.[29] Many observers have argued that the out-migration of doctors, teachers, engineers, and other highly skilled manpower has left shortages which it will take years of training to fill. The policies different Middle Eastern countries have adopted to deal with these issues are discussed in chapter 11.

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[28] See Georges Sabagh, "Migration and Social Mobility in Egypt," *Rich and Poor States in the Middle East*, op. cit., pp. 72-73.

[29] Choucri, op. cit., p. 9-4 and ibid., pp. 72-73.

SOCIAL/POLITICAL CONTEXT

Technology transfer both affects and is affected by the social and political milieu in which it occurs. In the Middle East, religious and cultural factors, domestic social strains, and regional politics all play a role in technology transfer, in addition to the economic and manpower factors described above. This section briefly discusses the role of Islam, social stratification, social attitudes toward work and women, and regional politics as they relate to technology transfer to the Middle East.

SOCIAL FACTORS

The past decade in the Middle East has been characterized by two sometimes contradictory tendencies: increased modernization, secularization, and/or "Westernization" on the one hand, and a greater reaffirmation of Islamic traditional values on the other.

Rapid economic development has brought with it substantial change in social structures and attitudes throughout the Middle East. Until the middle of this century, the Middle Eastern countries under review were largely tribal-nomadic or agricultural societies where Islam formed the basis of culture and tradition.

The migration to the towns and the settlement of nomads, however, which came with economic growth and industrialization, in some cases changed the social systems and attitudes of the indigenous populations and created new cleavages and classes along urban/rural and social and economic lines. Economic development and technology transfer coincided with the development of new urban upper-middle classes and the emergence of a new class of often Western-educated technocrats. The influx of foreigners to the Middle East brought with it new Western ideas and consumer goods often embraced by the indigenous populations.

In all of the countries under review, however, these changes have been accompanied by powerful conservative strains as well. First, the vast majority of the indigenous populations remain relatively removed from the industrialization and technology transfer process; indeed, a schism has sometimes appeared in these countries between this majority and the minority of people who are most involved in and who reap the benefits of economic growth. Among almost all groups and classes, moreover, traditional and family/kinship values and norms, based on the Islamic religion, endure. More than 90 percent of the population of each of the six countries under study are Muslims, and Islam remains an important source of legitimacy for Middle Eastern governments—as well as for opposition groups. Although the interpretation of Islamic tradition and culture varies widely among nations and different social classes and groups,[30] the rise of Islamic fundamentalism throughout the Middle East has reaffirmed the importance of retaining Islamic tradition and culture in the face of economic change.

Opinions vary as to the context these social factors provide for technology transfer. One argument is that Middle Eastern and Islamic tradition and culture are intrinsically at odds with technology transfer from the West. This view is based on the notion that Islam is fundamentally resistant to change, and thus represents an impediment to economic development and technology transfer. Although this view has generally been discredited, it is one that still colors the vision of some Western observers.[31]

Some Middle Easterners, however, also worry about an incompatibility between Islam and Western technology. Here, the argument is that Western technology must be carefully selected and adapted to meet indigenous needs, or the viability of a traditional, Islamic social and cultural fabric will become severely threatened. Contemporary Western technology, proponents of this view argue, embodies its own Western values, both in terms of those inherent in the technology and those embodied in the channels through which technology is transferred. These values are considered to conflict with the human values, traditions, and social patterns found in traditional Muslim society. In line with this view, many Islamic fundamentalist groups, for example, are now advocating a return to the fundamental values of the past and a rejection of much that is "modern" or "Western." In their view, technology transfer is a disruptive process, one at odds with traditional society and demanding fundamental changes in the recipient country's whole social fabric to conform to the values embodied in the technology. In this view, technology transfer may be often rejected outright, or the stress laid on transferring "appropriate" technology.

In contrast, others believe that Middle Eastern and Islamic culture and tradition complement technology transfer from the West. Proponents of this view argue that nothing inherent in Islam would oppose technology transfer; on the contrary, Islamic tradition is regarded as having traditionally encouraged scientific inquiry and modernization, and technology transfer is regarded as a means of enhancing this process. Resistance to technology transfer in the name of Islam, proponents of this view argue, therefore has little to do with the essence of Islam itself. Instead, they argue, Islam is being used simply as a rallying cry or a source of legitimacy on the part of those disaffected social or economic groups opposed to technology transfer in one form or another. "Islam," one such observer writes, "is an instrument espoused both by incumbent governments and opposition forces as they . . . try to obtain legitimation and mass support for their programs and policies."[32] Proponents of this view argue that values associated with Western technology can be shaped by the social milieu into which this technology is transferred, and combining science and faith has been the theme of several writings and political parties in the Middle East.[33] Depending on the technology and its method of transfer, proponents of this view argue, Western technology may be used to buttress, if not to further promote, traditional values and beliefs.[34]

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[30] The underlying current in all of the countries under review, the precise nature of "Islam" is nevertheless quite varied, with sharp splits among Sunni and Shi'ia, fundamentalist and more liberal, urban, and rural, etc. The fundamentalist Shi'ia Islam of the Ayatollah Khomeini, for example, is in many ways different from the conservative Sunni Islam of the government of Saudi Arabia or the more liberal interpretations in Egypt. In many Middle Eastern countries, the more symbolic and socially conservative popular Islam of the poorer classes contrasts with the more liberal, intellectualized Islam of the wealthier, educated classes. In all cases, however, Islam is a key factor in individual and group identity. See, for example, Michael Hudson's discussion in "The Islamic Factor in Syrian and Iraqi Politics," *Islam in the Political Process,* James P. Piscatori (ed.) (Cambridge, Mass., 1983).

[31] For a discussion of some of these arguments, see Michael C. Hudson, "Islam and Political Development," *Islam and Development,* John L. Esposito (ed.) (New York: Syracuse University Press, 1980), pp. 1-25. For a discussion of this view as relevant to the developing world as a whole, see, for example, Denis Goulet, *The Uncertain Promise* (New York: IKOC/North America, Inc., 1977), pp. 17-30.

[32] Hudson, op. cit., p. 13. Whether in economic or political affairs, another observer argues, Islam has become "the language of both power and resistance to power" (Vatin, p. 98 in Piscatori).

A third argument is a combination of these two. In this view, technology transfer is viewed as intrinsically neither destructive nor supportive of traditional Islamic values, but as having the potential to lead to a new and distinct situation that contains elements both traditional and modern. As illustrated in the case of Japan, for example, adherents of this position argue that it is possible for Western technology to interact synergistically with traditional culture, neither destroying the traditional nor the modern, but ultimately creating a new and more productive pattern.[35]

Because interpretations of Islam vary, there is no one way in which Islam can be said to blend or conflict with economic development and technological change so as to resolve these arguments. Little in the writings of Islam and

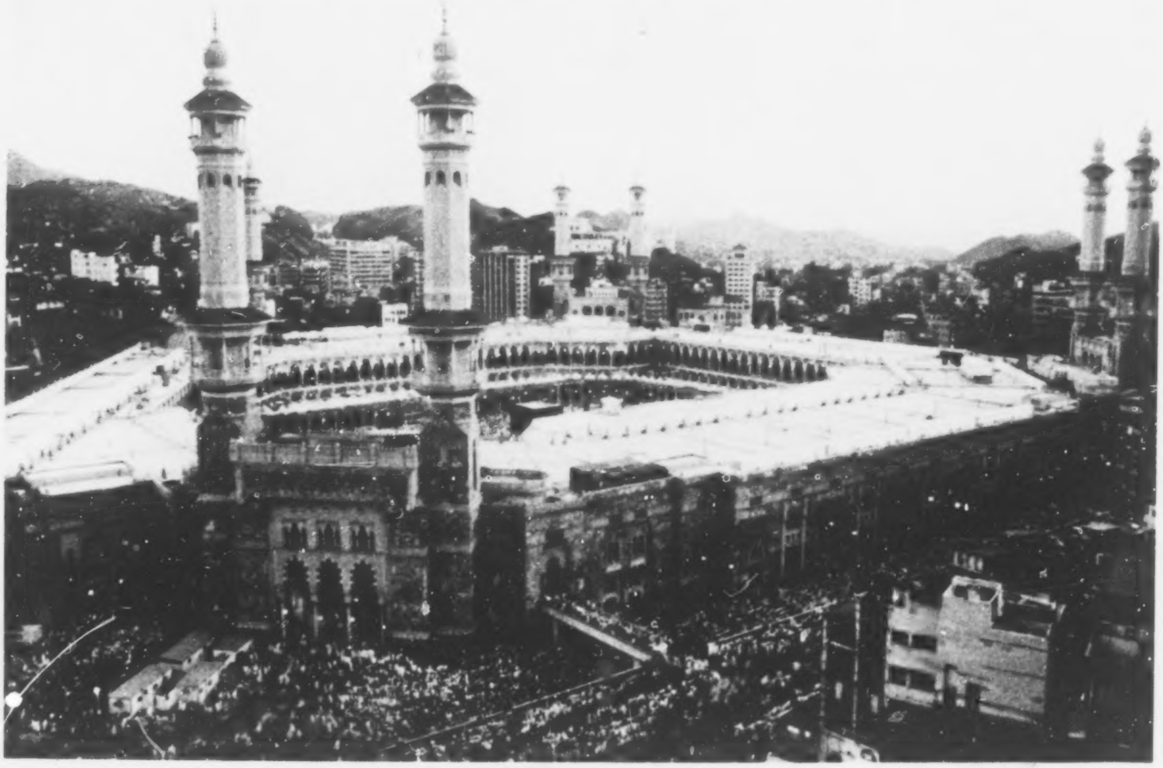

Photo credit: Saudi Arabian Ministry of Commerce

Muslims from all over the world travel to Mecca in Saudi Arabia. For centuries, this has been a place of pilgrimage religious practice spells out clearly the extent and ways in which technology should be used or adopted. Because all practices associated with economic or technological change are not explicitly discussed, the evaluation of technology and its consequences by Islamic precepts has had to rely on interpretation of law and practice, and these have varied among countries and Islamic groups. Thus, Islamic tradition and culture can be viewed as comprising a social context that may be either hostile to or favorable for technology transfer, depending on other social factors and the attitudes of the government in power.

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[33] See, for example, Ziauddin Sardar, *Science, Technology and Development in the Muslim World* (London: Croom Helm Ltd., 1977).

[34] Ziauddin Sardar, ibid. For a broader discussion of this, see John D. Montgomery, "Development Without Tears," *Technology and International Affairs*, Joseph S. Szyliowicz (ed.) (New York: Praeger, 1981), esp. pp. 155-170.

[35] For a discussion of some of these ideas, see Charles Weiss, Jr., "Mobilizing Technology for Developing Countries," World Bank Reprint Series: No. 95, reprinted from *Science*, vol. 203, Mar. 16, 1979, p. 1.

In addition to issues concerned with the interplay of Islamic tradition and culture with technology transfer, two commonly cited examples of the effect of social attitudes on technology transfer are attitudes towards female employment and attitudes concerning occupational prestige. In light of the labor constraints discussed above, both of these issues are often regarded as having important implications for technology transfer.

While the role of women in Middle Eastern Islamic societies is certainly complex, and although there is wide variation among Middle Eastern countries, a woman's role in the Middle East has traditionally been outside of the labor force and segregated from men. One result has been to limit the potential size of the total labor force. Especially for the labor-short countries, this may have contributed to the manpower shortages affecting economic development and technology transfer.[36] Today, evidence suggests that the role of women and attitudes toward female employment in the Middle East have been changing: even in Saudi Arabia—among the most conservative Middle Eastern countries in this regard—the proportion of women in schools and in the labor force has grown considerably since the early 1970's. But the number and proportion of women employed is still low, especially in the professional and technical occupations, and female employment probably will not significantly help to meet expected labor demand for some time.

Some observers have also noted that common historically or culturally shaped prestige values, such as aversion to manual or industrial labor, can also act as constraints on technology transfer. The "high value placed on leisure," two specialists on Middle Eastern manpower note, the "disinclination to work in manually strenuous jobs," and "the desire not to be subordinate to an impersonal outside authority" comprise, in the words of these authors, "an important explanatory factor behind many Saudi Arabians' reluctance to enter a wide spectrum of employments in the modern sector."[37] Similar observations have been made regarding even those Middle Eastern countries where the labor force is regarded as more highly developed: in Egypt, another observer notes, social values have reduced

Photo credit: Embassy of Kuwait

Women students in laboratory

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[36] See, for example, discussion in *Al-Riyad*, Nov. 22, 1983, p. 17 translated in "Study Examines Role of Women in Replacing Foreign Labor Force," reported in *JPRS: Near East, South Asia*, Jan. 11, 1984, pp. 80-84.

[37] See J. S. Birks and C. Sinclair, "The Kingdom of Saudi Arabia and the Libyan Arab Jamehiriya: The Key Countries of Employment," Migration for Employment Project, Working Paper WEP 2-26/WP39 (Geneva: International Labor Organization, 1979), esp. pp. 21-26. As explained by another observer, despite the enormous achievements accomplished by Islamic scientists and thinkers throughout the centuries, "the emphasis on enjoying God's bounty rather than earning God's grace through hard labor tends to deprive Saudi society of a work ethic capable of efficiently harnessing the country's human resources." See John A. Shaw and David E. Long, *Saudi Arabian Modernization*, No. 89, vol. X of the Washington Papers, series published by the Center for Strategic and International Studies, Georgetown University (Washington, D.C.: Praeger Special Studies, 1982), p. 2.

technical education and vocational education to "a second-class type of education." "Social values," this analyst adds, "may be the factor which has the strongest impact on the educational and training system."[38] Because one aim of technology transfer is the transfer of skills to indigenous personnel, the low prestige associated with technical fields may well be a constraint on the technology transfer process. But examples such as the successful training of Saudis in ARAMCO to take over many managerial and technical jobs would suggest that, like female employment, these attitudes too may be changing.

In other words, traditional values and beliefs provide a mixed context for technology transfer to the Middle East. On the one hand, traditional values and beliefs could be regarded as impeding technology transfer, to the extent that the latter shapes new attitudes and visions often disconsonant with the patterns of traditional Islamic society. At the same time, traditional attitudes can enhance technology transfer in other ways—for example, by providing legitimacy for technology transfer decisions or creating a context for increased cooperation in technology transfer efforts. A central challenge for Middle Eastern governments today is to balance economic development aims with the maintenance of Islamic values and beliefs, and to avoid choices that might result in social discontent that might find its expression in opposition to technology transfer.

POLITICAL CONTEXT

Political systems in the Middle East vary greatly, ranging from the oldest ruling monarchy in the world, to republican and socialist systems. These different political systems directly shape the way technology transfer decisions are made and implemented.

Of the countries under review, for example, the governments of two, Saudi Arabia and Kuwait, are presently monarchies, with leadership based on heredity. While the last 10 years have seen the development and growth of a cabinet government and ministries in both countries, power still resides in the hands of the monarch—the King in Saudi Arabia, the Amir in Kuwait. Neither country has political parties; public opinion is expressed through the National Assembly in Kuwait (a formally elected representative institution), or the majlis in Saudi Arabia (an informal institution). Prerevolutionary Iran was also a monarchy with, theoretically, an independent legislature (a majlis, or parliament) and an independent judiciary. In practice, the monarchy was the central place where power resided, and the Shah personally played an active role in all affairs of state.

Both Iraq and Algeria, on the other hand, are one-party states, socialist in orientation and also based on Islam. Iraq's political system today is under the control of one party, the Arab Socialist Baath (Resurrection) party, with the Party's high command (the Regional Command) being headed by one dominant leader: Saddam Hussein. Like Iraq, Algeria is socialist in orientation and legally a single-party state, with the Front de Liberation Nationale (FLN) as the official party.

In contrast, since 1952 Egypt has had a republican form of government, with an elected president as head of state and government. The executive branch is headed by the president and his cabinet, which dominates the unicameral elected legislative body, the People's Assembly, and the judiciary, although each is constitutionally independent.

Also providing a perhaps unique context for technology transfer are the strains of conflict and cooperation that characterize Middle Eastern regional politics. For the past two decades, almost every country in the Middle East has been involved in war: conflicts ranging from the Arab-Israeli conflict, the Iran-Iraq War (and the revolution in Iran) and, for countries such as Algeria, the West Saharan dispute. These conflicts have set the stage for political alliances in the Middle East, often pitting Muslim against Muslim, and one Middle East government against another. At the same time, however, efforts to promote greater Islamic and Arab ties continue through a myriad of regional organizations established for cooperation in the political, social, and economic arenas. Because of the importance of oil to the world economy—and especially after the Soviet invasion of Afghanistan, which brought Soviet forces to within only a few hundred miles of the Gulf region—the Middle East has also been seen as an area of great geostrategic significance and superpower rivalry.

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[38] See Bent Hansen and Samir Radwan, *Employment Opportunities and Equity in a Changing Economy: Egypt in the 1980s* (Geneva: International Labour Organization, 1982), p. 255.

IMPLICATIONS FOR TECHNOLOGY TRANSFER

These domestic, regional, and international issues affect all aspects of political and economic relations in the Middle East and create a political context for technology transfer that extends beyond questions of resource or manpower availability. A key challenge for policymakers is to make decisions about technology transfer which take into account economic, political, and social factors and to ensure that these decisions are consistent with broader interests in the Middle Eastern region as a whole. The ways in which different governments have attempted to meet these challenges are discussed in chapter 11.

CHAPTER 4

Technology Trade With the Middle East

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CHAPTER 4

Technology Trade With the Middle East

INTRODUCTION: EXPLOSIVE GROWTH OF TRADE AFTER 1973

In recent years, exports to the Middle East have become a significant fraction of the total exports of the major industrial countries. For instance, U.S. 1982 exports of all kinds to the Middle East ($17.5 billion) were 8 percent of the total U.S. exports in 1982 (table 12). The other major non-Communist industrial countries also exported comparable or greater percentages to the region.

Industrial-country exports to the Middle East reached this high level after a decade of phenomenal growth. Total Middle Eastern real expenditure on imports, most of which came from the industrial countries, increased at an average annual rate of 15.3 percent in 1973-82, compared to 5.4 percent for world trade as a whole.[1] After oil prices escalated following the 1973 oil crisis, the value of industrial-country imports from the Middle East increased rapidly, and most industrial countries experienced large bilateral balance of payments deficits with the region. A jump in balance of payments deficits occurred again in 1979, when oil prices rose substantially in real terms and the value of industrial-country imports from the Middle East increased substantially.

Technology trade with the Middle East has also grown rapidly within this dynamic overall trade context. Real expenditure on U.S. exports of production machinery and equipment to the Middle East grew rapidly, at an average rate of 18 percent per annum over the period 1970-82.[2] The export experience of other industrial countries in this category was similar, except for Japan's, whose trade expanded even more rapidly, and France's, whose trade grew more slowly. Contracts for large projects, another technology trade indicator, also expanded rapidly from a small base after 1978.

On the recipient side, Middle Eastern countries are a diverse group, demographically, economically, and politically. This diversity is also reflected in their trade growth. The real value of total exports from Middle Eastern countries grew at very different rates for the countries in OTA's Middle Eastern sample,

Table 12.—The Importance of Exports to the Middle East for the Major Industrial Countries

Country	Exports to Middle East as percent of country's exports, 1970	Exports to Middle East as percent of country's exports, 1982	Machinery and equipment exports as percent of exports to Middle East, 1982
United States	2%	8%	67%
Japan	3	12	59
West Germany	2	8	68
France	6	10	52
United Kingdom	4	9	51
Italy	4	15	56

SOURCE: International Monetary Fund, *Direction of Trade Statistics Yearbook*, 1975 and 1983 volumes.

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[1] Calculated from International Monetary Fund, *Direction of Trade Statistics Yearbook*, 1979, 1983. Deflated using U.S. gross national product deflator.

[2] "Production machinery and equipment" refers to nontransportation machinery and equipment as it appears in OECD trade data in the United Nations trade data categorization: SITC (Revision 1) categories 71-72.

primarily because they exported varying amounts of petroleum. As seen in table 13, the average annual growth rates of the real value of total exports of the six countries examined most closely by OTA ranged from 3 percent in the case of Kuwait to 17 percent in the case of Saudi Arabia over the period 1973-82.

Total imports of the Middle Eastern countries also grew at diverse rates (table 13), because the countries that exported large quantities of petroleum had large positive trade balances, while the countries exporting smaller amounts of oil were constrained by small surpluses or negative balances. During 1983 and 1984 changes in the petroleum market—price and quantity shortfalls from earlier levels—resulted in reduced export revenues. Together with continuing high imports, the result has been severely diminished trade surpluses and increased trade deficits. (Table 13 gives imports as a fraction of exports for 1979 and 1982 for six countries.) This chapter analyzes technology trade with the Middle East over the last decade and evaluates factors affecting the export shares of the major technology suppliers.

Table 13.—Trade With the Middle East—Data for Six Importing Countries

Country	Average growth of real exports, 1973-82[a]	Average growth of real imports, 1973-82[a]	Imports as percent of exports	
	(percent per annum)		1979	1982
Saudi Arabia	17%	25%	41%	43%
Egypt	8	17	198	239
Algeria	14	9	75	71
Iraq	12	27	40	159
Iran	3	3	38	59
Kuwait	3	17	28	84

[a]Export or import values adjusted for changes in the general purchasing power of the dollar using the U.S. GNP deflator.

SOURCE: International Monetary Fund, *Direction of Trade Statistics Yearbook*, 1979 and 1983 volumes, world table, pt. A.

TECHNOLOGY TRADE WITH THE MIDDLE EAST IN GLOBAL CONTEXT

Exports from industrial countries to all developing countries considered together are very large business. West European countries send about one-third of their total exports, and also of their manufactured goods exports, to less developed countries (LDCs).[3] The United States and Japan export even higher percentages of exports to LDCs—somewhat less than half of both total and manufactured exports for the United States and somewhat more than half of both categories for Japan (see table 14).

There is a contrast between the United States and Japan, on one hand, and the West European countries, on the other, in exports of machinery and equipment, a trade category which gives a closer indication of technology transfer. While the United States and Japan had the highest supplier shares in 1982, they sent only 20 and 27 percent, respectively, of their production machinery exports to LDCs to the Middle East. The West European countries, with lower market shares, sent 35 to 47 percent to the Middle East (see table 15).

To put the Middle East in world context, for industrial countries, individual Middle Eastern countries are in some cases export markets as large as all but their largest industrial coun-

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[3] OTA categorizes the Middle East high-income oil exporters (Libya, Kuwait, Saudi Arabia, and UAE) as LDCs for purposes of this calculation. Source of the data cited in this paragraph is the World Bank, *World Development Report 1983* (New York: Oxford University Press, 1983), tables 12 and 13.

Table 14.—Industrial-Country Exports to the Middle East in World Context

Country	Total exports to LDCs[a] as percent of country's exports 1981[b]	Total exports to Middle East as percent of exports to all LDCs 1982	Manufactured exports to LDCs as percent of total manufacturing exports, 1980[b]	Manufactured exports to Middle East as percent of those to all LDCs, 1982
United States	43%	16%	45%	19%
Japan	51	25	51	26
West Germany	24	43	22	44
France	30	33	28	33
United Kingdom	30	31	33	32
Italy	36	53	30	52
Industrial market economies[c]	32	28[d]	31	30[d]

[a] Less developed countries (LDCs) are defined here to include the high-income oil producers of the Middle East: Saudi Arabia, Kuwait, Libya, and the United Arab Emirates.
[b] Calculated from percentages in *World Development Report 1983;* there may be some inaccuracy due to rounding.
[c] Fourteen West European countries plus the United States, Canada, Japan, Australia, and New Zealand.
[d] United States, Japan, West Germany, France, United Kingdom, and Italy only.

SOURCES: World Bank, *World Development Report 1983*, tables 12 and 13; Organization for Economic Cooperation and Development, Trade Series C, obtained from Data Resources, Inc., data bank.

Table 15.—Production Machinery Exports to the Middle East in World Context, 1982[a]

Country	Country's market share of production machinery exports to the Middle East[b]	Production machinery exports to Middle East as percent of country's total production machinery exports to LDCs
United States	24%	20%
Japan	23	27
West Germany	19	41
France	12	38
United Kingdom	13	35
Italy	10	47

[a] SITC (Revision 1) categories 71-72. Nontransportation machinery and equipment (includes electrical-mechanical consumer durables).
[b] Data for 15 countries: Saudi Arabia, Algeria, Egypt, Iran, Iraq, Kuwait, Libya, United Arab Emirates, Syria, Lebanon, Jordan, Qatar, Oman, North Yemen, and South Yemen.

SOURCE: Organization for Economic Cooperation and Development, Trade Series C, obtained from Data Resources, Inc., data bank.

try trading partners. For instance, Saudi Arabia was the sixth largest customer of the United States in 1982, larger than France. Iran was in a strong bilateral position with the United States in 1978; at that time it was the tenth largest export market for the United States. As other examples, Algeria was the ninth largest customer for France in 1982, and Libya was the eighth largest buyer for Italy in the same year.

These data indicate clearly that the Middle East is important in world trade in general, and particularly for imports of machinery and equipment.

INDICATORS OF TECHNOLOGY TRADE WITH THE MIDDLE EAST

This section analyzes a number of indicators of technology trade with the Middle East: machinery and equipment imports, large contracts, and direct investment in the Middle East.

ANALYSIS OF MACHINERY AND EQUIPMENT IMPORTS

Middle East Imports of Machinery and Equipment

The size and prominence of machinery and equipment imports into the Middle East is striking. As table 16 shows, in recent years more than half of the Middle East's imports from the major industrial countries have consisted of machinery and equipment. In this limited sense, trade with the Middle East can be thought of as the exchange of "oil for technology."

In 1982, imports of machinery and equipment into 15 Middle East countries[4] and from the six major industrial countries were valued at more than $42 billion. These imports from six industrial countries constituted 57 percent of total imports for the 15 Middle Eastern countries, according to official trade statistics.[5] The predominance of machinery and equipment imports was also apparent for the individual countries. In 1982, the percentage of machinery and equipment imports varied from 51 percent for Iran to 67 percent for Iraq (see table 17).

These machinery and equipment import percentages were much higher than those of other large groups of countries—e.g., middle-income LDCs (31 percent) or even industrial countries (22 percent).[6] The Middle East has thus imported machinery and equipment at a rate unmatched by other developing countries during the past decade.

Table 16.—Imports Into Middle Eastern Countries From Major Industrial Countries, 1982[a]

	Total 6 countries[b]		Total 15 countries[c]	
Import category	Millions of dollars	Percent	Millions of dollars	Percent
Machinery and equipment	$32,663	57.7%	$42,070	57.0%
Nonelectric	11,262	19.9	13,945	18.9
Electric	8,021	14.2	10,394	14.1
Telecommunication	1,724	3.0	2,358	3.2
Electrical medical	118	0.2	144	0.2
Other electric	6,179	10.9	7,892	10.7
Transport	11,235	19.8	14,523	19.7
Road vehicles	8,577	15.2	10,819	14.7
Aircraft	1,351	2.4	1,810	2.5
Other transport	1,307	2.3	1,895	2.6
Other imports	23,939	42.3	31,746	43.0
Food, beverage and tobacco	4,036	7.1	5,204	7.0
Material, chemical, miscellaneous	5,849	10.3	8,424	11.4
Other manufactures	14,055	24.8	18,119	24.5
Total imports	$56,603	100.0%	$73,816	100.0%

[a] Data are for the six major industrial countries: United States, Japan, United Kingdom, France, West Germany, and Italy only.
[b] Saudi Arabia, Iran, Algeria, Egypt, Iraq, and Kuwait.
[c] The above six countries plus Libya, United Arab Emirates, Syria, Lebanon, Jordan, Qatar, Oman, North Yemen, and South Yemen.

SOURCE: Organization for Economic Cooperation and Development, Trade Series C, Data Resources, Inc., data bank.

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[4] The 15 countries are listed in the footnote below table 16.

[5] Saudi Arabia, Egypt, Iraq, Iran, Algeria, and Kuwait also had a similarly high percentage of machinery and equipment imports (table 16).

[6] The World Bank, *World Development Report, 1983*, table 11. These percentages apply to 1980.

Table 17.—Imports Into Six Middle Eastern Countries From Six Major Industrial Countries, 1982 [a]
(millions of dollars)

Import category	Saudi Arabia	Egypt	Iraq	Iran	Algeria	Kuwait
Machinery and equipment	$13,757	$3,335	$7,560	$2,069	$3,164	$2,778
Nonelectric	4,850	1,349	2,283	724	1,272	784
Electric	3,405	885	1,985	434	554	758
Telecommunication	658	268	526	52	86	134
Electrical medical	45	9	16	9	31	7
Other electric	2,702	608	1,442	373	437	617
Transport	4,676	918	2,599	754	1,169	1,119
Road vehicles	3,687	487	2,027	557	1,013	805
Aircraft	620	218	229	103	50	131
Other transport	368	213	343	94	106	183
Other imports	10,333	3,018	3,763	1,991	2,670	2,164
Food, beverage and tobacco	1,353	1,005	462	248	772	195
Material, chemical, miscellaneous	2,226	994	605	871	660	493
Other manufactures	6,753	1,019	2,696	872	1,238	1,476
Total imports	$24,090	$6,353	$11,324	$4,060	$5,834	$4,942
Machinery and equipment imports as percent of total imports	57.1%	52.5%	66.8%	51.0%	54.2%	56.2%

[a] Data are for the six major industrial countries: United States, Japan, United Kingdom, France, West Germany, and Italy only.
[b] Saudi Arabia, Iran, Algeria, Egypt, Iraq, and Kuwait.
[c] The above six countries (b) plus Libya, United Arab Emirates, Syria, Lebanon, Jordan, Quatar, Oman, North Yemen, and South Yemen.

SOURCE: Organization for Economic Cooperation and Development, Trade Series C, Data Resources, Inc., data bank.

The bulk of imports was probably destined for nonmanufacturing uses, such as consumer use and infrastructure development.[7] This situation is not surprising because manufacturing (which includes oil refining and petrochemicals) has been a relatively small contributor to the gross domestic product (GDP) in five of the six countries, as shown in table 18.[8] Revealingly, the ratio of services to manufacturing output in five of the six countries under study is well above the average of both low and middle-income developing countries (table 18).[9]

Telecommunications

Imports of telecommunications equipment indicate a major effort to build the telecommunications infrastructure in the Middle East, with over $3 billion in annual telecommunications imports (1980) for the 15-country region. A substantial percentage of telecommunications imports consisted of user (consumer and business) electronics—television and radio receivers and sound equipment. Table 19 gives telecommunications imports in the categories available that most nearly correspond to user electronics and telecommunications infrastructure.[10]

Defined in this way, imports into the Middle East of equipment for telecommunications infrastructure amounted to $2 billion in 1980, with $750,000 imported into Saudi Arabia

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[7] A modern production enterprise requires general electrical equipment, machine tools, transportation equipment, materials-handling equipment, data-processing equipment, pipes, building materials, etc. In the international trade data these are classified under types of equipment and materials and thus cannot be straightforwardly linked with their industrial destinations.

[8] Although manufacturing industries in general are not yet important in five of the six Middle Eastern countries, downstream petroleum-based industries are present in all six. Unfortunately, identification of petroleum refining and petrochemical production with particular equipment categories in the trade data is not possible because the equipment components that figure importantly in oil refining and petrochemical installations, pumps, pipes, valves, boilers, and computers, not to mention more general industrial machinery, cannot be associated with petrochemical/refining use as distinguished from infrastructural, construction, or other uses.

[9] The high ratios of services to manufacturing output for the Middle Eastern countries are probably slightly underestimated, since petroleum-processing industries (included in manufacturing) record contributions to GDP that may be overestimated, due to the fact that oil-input costs in enterprise accounting records are set below market value. The Egyptian ratio, in particular, is undoubtedly overstated for this reason.

[10] The categories overlap to a certain extent, and the definitions differ for the 2 years, since different standard trade classification systems are used. The "infrastructure" component does, however, provide at least an indication of telecommunications imports that are used in building the national telecommunications system.

Table 18.—Structure of Production in Middle East Countries Compared to Other Developing Countries, 1981

Country	Manufacturing as percent of gross domestic product[a]	Ratio of services to manufacturing output[a]
Kuwait	4%	7
Saudi Arabia	4	5
Algeria	11	3.5
Iran[b]	11	3.5
Iraq[c]	6	3
Egypt[d]	32	1
Developing country averages:		
Low-income countries	16	2
Middle-income countries	22	2

[a] Calculated from 1- and 2-digit percentages presented in source: thus there may be some inaccuracy due to the original rounding in the source.
[b] Data for 1960.
[c] Data for 1979.
[d] Data for 1980.
NOTE: Services as defined in the source do not include electricity, water, gas, and construction.
SOURCE: The World Bank, *World Development Report 1983*, table 3.

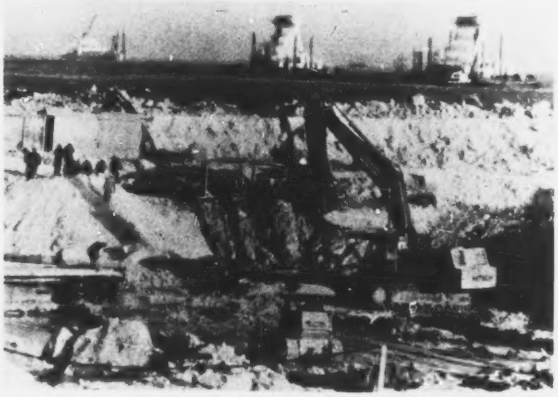

Photo credit: United Nations/J. O'Brien

Oil tanker terminal under construction at Jubail, Saudi Arabia in 1977. Over 6,000 Korean workers were employed on this project

alone. In 1978 and 1980, equipment for telecommunications infrastructure constituted between 60 and 70 percent of all telecommunications equipment imports into the 15-country region. This infrastructure component also constituted 5 to 6 percent of all machinery and equipment imports in the same years.

Airline Development

Data on imports of aircraft and parts are indicators of the development of airlines in the Middle East. Table 20 gives data for aircraft and parts imports to various countries and country groups for 1978 and 1982. In these years aircraft and parts were a substantial category of imports, in excess of $1.5 billion per year. They were on the order of 2.5 percent of total imports from industrial countries and 4 to 5 percent of machinery and equipment imports.

The import bill for aircraft differed markedly from country to country. In 1978, for instance, Saudi Arabia, Kuwait, and Iran in particular built up their commercial air fleets.

Medical Equipment

"Medical equipment" appears in the trade data in two categories. One category is assigned to electrical medical equipment only and the other includes along with medical equipment other types of professional, scientific, and control instruments. Data in these two categories are presented in table 21. Electrical medical equipment alone has been a small part of Middle Eastern imports of machinery and equipment, not even 1 percent. Middle Eastern countries have, however, imported about $1 billion of professional and scientific instruments annually.

ANALYSIS OF CONTRACT DATA

Technology transfer to the Middle East has involved large contracts as an important mechanism in recent years. Although no official data on contract awards exists, the larger ones are monitored in the trade press. OTA has compiled data on contract awards during recent years.[11] Frequently, the contract award

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[11] OTA's major sources have been the *Middle East Economic Digest* (MEED), Projects Research, Inc., reports, the *Middle East Economic Survey*, and The Financial Times. MEED, which is the primary source, reports individual contracts on a weekly basis, and "MEED Consultants" issues a semiannual publication, *Middle East Contracts, Directory and Analysis*.

Table 19.—Middle East Telecommunications Imports From Industrial Countries, Selected Years

Country or country group	Telecommunications imports, 1978[a] (millions)	Percent "infrastructure"[b]	Telecommunications imports, 1980[c] (millions)	Percent "infrastructure"[b]	Telecommunications imports 1982[d] (millions)
	(1)	(2)	(3)	(4)	(5)
Saudi Arabia	$ 786	56.6%	$1,164	63.7%	$ 658
Egypt	195	71.8	258	69.8	268
Iraq	207	79.7	357	71.4	526
Iran	360	81.4	120	62.5	52
Algeria	125	80.8	138	72.5	86
Kuwait	150	44.7	294	30.6	134
Total 6 countries	$1,823	66.5%	$2,331	61.8%	$1,724
Total 15 countries	$2,417	68.2%	$3,362	59.3%	$2,358
As percentage of total imports	2.9%	2.0%	4.0%	2.4%	3.2%
As percentage of machinery and equipment	7.4%	5.1%	10.3%	6.1%	5.6%

[a] SITC Revision 1 #724—Telecommunications Apparatus.

[b] Telephone switching and line equipment and television broadcast equipment, which might be called "infrastructure," are included in SITC Revision 1 #7249 and SITC Revision 2 #726, and it is these subcategories that are used to calculate the percentages in cols. 2 and 4. While these categories do exclude television and radio receivers (and also gramophones for #726), they include all other telecommunications equipment and parts and, hence only roughly measure the infrastructure component.

[c] SITC Revision 2 #76—Telecommunications and Sound Recording and Reproducing Apparatus and Equipment.

[d] SITC Revision 1 #724. 1982 data for six major industrial countries only.

Table 20.—Middle East Aircraft Imports From Industrial Countries, Selected Years (millions of dollars)

Country or country group	Aircraft imports, 1978[a]	Aircraft and parts imports, 1978[b]	Aircraft and parts imports, 1982[c]
Saudi Arabia	$ 267	$120	$ 620
Egypt	26	21	218
Iraq	0	14	229
Iran	182	90	103
Algeria	3	7	50
Kuwait	170	21	131
Total 6 countries	$ 648	$278	$1,351
Total 15 countries	$1,016	$559	$1,810
As percentage of total imports	1.5%	0.8%	2.5%
As percentage of machinery and equipment	3.1%	1.7%	4.3%

[a] SITC Revision 1 #734 less # 7349—Aircraft and parts less parts.

[b] SITC Revision 1 #7349—Parts of aircraft, airships and balloons (not including rubber tires, engines, or electrical parts) and airships and balloons.

[c] SITC Revision 1 #734—Aircraft and parts. 1982 data for six major industrial countries only.

SOURCES: **1978:** United Nations, "Trade With Industrial Countries," supplement to the *World Trade Annual;* **1982:** Organization for Economic Cooperation and Development, Trade Series C, Data Resources, Inc., data bank.

data has been extensive enough to allow OTA to separate the projects into the expenditure categories of technical services, equipment supply, and construction.[12] Table 22 includes contract values for the period 1980-82.

A great number of contract awards have been made in recent years. In 1980-82, total contracts awarded (and recorded) were valued at $40 billion to $75 billion per year. These contracts were highly concentrated in a few countries. In 1981, Saudi Arabia and Iraq awarded the greatest shares of the contracts.

The concentration of contract awards in various countries has shifted strikingly in recent years, owing to political events and to events

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[12] Difficulties in analyzing contract data were discussed in ch. 2 at greater length. They include incompleteness (with large projects disproportionately represented), double counting of contracts and subcontracts, the fact that awards are subject to substantial changes in both project design and amount, and the paucity of data on certain projects.

Table 21.—Middle East Medical Equipment Imports From Industrial Countries, Selected Years (millions of dollars)

	1978		1980		1982	
Country or country group	Electrical medical equipment[a]	Professional and scientific instruments[b]	Electrical medical equipment[c]	Professional and scientific instruments[d]	Electrical medical equipment[a e]	Professional and scientific instruments[b e]
Saudi Arabia	$28	$ 445	$27	$ 322	$ 45	$301
Egypt	8	70	10	105	9	78
Iraq	7	90	18	153	16	132
Iran	22	256	7	84	9	55
Algeria	7	79	8	110	31	88
Kuwait	5	117	7	50	7	43
Total 6 countries	$77	$1,058	$76	$824	$118	$698
Total 15 countries	$99	NA	$99	$1,126	$144	$895
As percentage of total imports	0.1%	1.3%[f]	0.1%	1.3%	0.2%	1.2%
As percentage of machinery and equipment imports	0.3%	2.8%[f]	0.3%	3.0%	0.3%	2.1%

[a] SITC Revision 1 #726—Electrical apparatus for medical purposes and radiological apparatus.
[b] SITC Revision 1 #86—Professional, scientific, and controlling instruments; photographic and optical goods; watches and clocks.
[c] SITC Revision 2 #774—Electrical apparatus for medical purposes and radiologcal apparatus.
[d] SITC Revision 2 #87—Professional, scientific, and controlling instruments and apparatus, n.e.s.
[e] 1982 data for six major industrial countries only.
[f] Calculated on data for six Middle East countries.
NA - not available.

SOURCES: **1978:** United Nations, "Trade With Industrial Countries," supplement to the *World Trade Annual;* **1980:** Organization for Economic Cooperation and Development, *Statistics on Foreign Trade;* **1982;** Organization for Economic Cooperation and Development, Trade Series C, Data Resources, Inc., data bank.

Table 22.—Contract Awards by 15 Middle East Countries, 1980-82

Country or country group	Total contract awards 1980[a] (millions)	Percent of 15-country total[b]	Total contract awards, 1981[a] (millions)	Percent of 15-country total	Total contract awards, 1982 (millions)	Percent of 15-country total
Saudi Arabia	$15,697	37.1%	$21,847	28.5%	$27,107	60.3%
Egypt	1,709	4.0	4,248	5.5	1,382	3.1
Iraq	12,647	29.9	23,018	30.0	3,832	8.5
Iran	70	0.2	899	1.2	928	2.1
Algeria	1,083	2.6	1,375	1.8	2,704	6.0
Kuwait	3,522	8.3	3,564	4.6	2,814	6.3
Total 6 countries	$34,728	82.1%	$54,951	71.6%	$38,767	86.3%
Total 15 countries[b]	$42,304	100.0%	$76,789	100.0%	$44,939	100.0%

[a] Total contract awards refers to the annual contract amounts compiled in *Middle East Contracts: Data and Analysis*, MEED Consultants, London, semiannually. This is an incomplete total both because smaller contracts escape notice and because information on value is sometimes not available. There is an unknown amount of double counting of contracts and their subcontracts.
[b] Saudi Arabia, Iran, Algeria, Egypt, Iraq, Kuwait, Libya, United Arab Emirates, Syria, Jordan, Qatar, Oman. Lebanon, Yemen, and South Yemen are not included for 1980. These three countries awarded contracts in the MEED compilation of only $780 million in 1981.
NOTE: Total contract awards for 1983 amounted to $33,984 million for the six countries under review. Saudi Arabian contracts reported were valued at $14,980 million.

SOURCE: MEED Consultants, *Middle East Contracts: Data and Analysis*, various issues.

in the international oil economy. In certain past years Iran (in 1978) and Libya (in 1980) have both been large contract purchasers, but neither were large contract purchasers in 1981. In another example, Iraq was the largest contractor in the Middle East in 1981. In 1982 and 1983, however, Iraq scaled back its civilian contracting effort, primarily because of the war-related diminution of its oil revenues. Its payments on existing contracts were also cut back, leaving in jeopardy the completion of many projects contracted for earlier.[13]

Countries such as Saudi Arabia and Egypt have experienced large unexpected changes in their financial positions owing to the recent changes in the price of oil, and these changes have affected their willingness to undertake contracting on the same scale as previously. Saudi Arabian international contracts continued to expand in 1982, with total contracts of $27 billion, but in 1983 only about $15 billion in contracts were awarded.[14]

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[13] See, for instance, "West Germans in the Iraq Quagmire," *Financial Times*, Oct. 17, 1983, p. 14.

The annual amount of large construction and equipment contracts has varied greatly. Contracts like the $1.8 billion Siemens Group contract to install the new Cairo telephone system or the $3 billion Fluor Corp. contract to build a petrochemical complex at Jubail, Saudi Arabia, are not likely to be duplicated in these same countries. Since each such large contract is a significant fraction of a country's contracting in a given year, annual totals are quite variable.

With many of the large infrastructure contracts completed, service and maintenance has emerged as an increasingly important area of contracting. This is a natural follow-on to technology transfer in the original projects.[15] In general, as the structure of Middle Eastern economies changes the emphasis will shift toward management, financial, and technical services contracting.

OTA analyzed of contract awards in the Middle East for four of the technology sectors. Where information is available, the total contract amounts are broken down by technical services, equipment supply, and construction. Table 23 summarizes this information by technology sector.

Contracts with Saudi Arabia dominated the tabulation in all four sectors; three-fourths of all the contracts tallied were with Saudi Arabia. Iraq came in a distant second, with significant participation in three of the four sectors. Although Iraq was a significant contractor overall in 1980 and 1981, it did not invest in these sectors to nearly the extent that Saudi Arabia did. Iraq's civilian contracting program decreased markedly in 1982 owing to the Iran-Iraq War.

No contracts were reported for the construction of nuclear powerplants during the 1978-82 period. In fact, contracts for two 900-megawatt (MW) plants, which were to have been built in Iran by Framatome of France, were canceled in 1979, and a letter of intent given by Egypt to Westinghouse Electric of the United States was canceled in 1981. Nevertheless, as analyzed in chapter 9, a number of Middle Eastern countries are considering commercial nuclear power development. For instance, Egypt has accepted bids on a $2 billion nuclear power project.[16]

Saudi Arabia also was the only country extensively purchasing technical services in identifiable contracts. As noted in chapter 2, the technology transfer "package" normally includes technical and management assistance when the transfer is to developing countries with limited technical capabilities. Thus, the absence of identifiable technical services contracts does not mean that technical assistance was not provided, but rather that it may have been included in other contracts.[17]

ANALYSIS OF DATA ON DIRECT INVESTMENT

Direct investment from the industrial countries has not as yet been a major mechanism of technology transfer to the Middle East, except in petroleum extraction and refining. The U.S. direct investment position in the Middle East (excluding Israel and including Turkey) was only $3.3 billion in 1981 ($2.2 billion in

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[14] See, Edmund O'Sullivan, "Saudi-Arabia—The Construction Bubble Bursts," *Middle East Economic Digest*, June 17-23, 1983, pp. 8-12; "Proof That the Bubble Has Burst," *Middle East Economic Digest*, April 1983, special report.

[15] See "Service and Maintenance—The Way to Go in the Kingdom," *Middle East Executive Reports*, October 1983, p. 18; "Cleaning Up the City Streets," *The Middle East*, October 1983.

[16] *Financial Times*, Sept. 1, 1983, p. 1.

[17] The large Fluor contract to build the Jubail petrochemical complex is an example of both points. Although the technical services aspects of the contract were identified in press coverage of the contract, no amount was given; thus, in this case, it was not possible to ascertain the value of the technical services component. Much of the technical services (as an identifiable part of a turnkey project or separately) were to be provided in this project by multinational joint venture partners.

Table 23.—Contract Awards by Technology Sectors, 1978-82[a]

Technology sector	Millions of dollars				
	Technical services	Equipment supply	Construction	Total	Percent
Telecommunications	*$1,412*	*$9,339*	*$479*	*$11,230*	*100.0%*
Saudi Arabia	1,362	5,881	293	7,536	67.1
Egypt	21	2,442	4	2,467	22.0
Iraq	15	828	149	992	8.8
Iran	—	111	—	111	1.0
Algeria	1	4	26	31	0.3
Kuwait	13	73	7	93	0.8
Commercial airline support systems	*963*	*488*	*3,992*	*5,443*	*100.0%*
Saudi Arabia	953	338	2,348	3,639	66.9
Egypt	7	135	122	264	4.9
Iraq	3	11	1,486	1,500	27.6
Algeria	—	1	—	1	0.0
Kuwait	—	3	36	39	0.7
Medical services	*1,926*	*69*	*4,283*	*6,278*	*100.0%*
Saudi Arabia	1,925	31	2,950	4,906	78.1
Egypt	—	3	47	50	0.8
Iraq	—	16	1,264	1,280	20.4
Algeria	—	1	—	1	0.0
Kuwait	1	18	22	41	0.7
Petrochemical facilities	*54*	*884*	*4,804*	*5,742*	*100.0%*
Saudi Arabia	—	751	4,497	5,248	91.4
Egypt	—	—	168	168	2.9
Iraq	—	2	—	2	0.0
Algeria	54	—	—	54	0.9
Kuwait	—	131	139	270	4.7
Four sectors (total)	*4,355*	*10,780*	*13,558*	*28,693*	*100.0%*
Saudi Arabia	4,240	7,001	10,088	21,329	74.3
Egypt	28	2,580	341	2,949	10.3
Iraq	18	857	2,899	3,774	13.2
Iran	—	111	—	111	0.4
Algeria	55	6	26	87	0.3
Kuwait	14	225	204	443	1.5

[a]Incomplete coverage, especially for 1978-79 and 1982. See notes to table 30.

SOURCE: OTA compilation.

the petroleum sector) out of a world total of $227 billion (see table 24).

Other industrial countries have limited direct investments in the Middle East, with the United Kingdom being the principal source besides the United States. Data on their direct investments are often inadequate to determine their positions in individual countries.[18] While U.S. data on direct investment are better, country coverage is restricted and data are suppressed in various categories.[19]

Nevertheless, U.S. direct investment data do allow conclusions to be drawn concerning the role of direct investment in technology transfer to the Middle East. First, U.S. nonpetroleum direct investment in the Middle East is small compared to that in developing

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[18] In 1978, the United Kingdom had direct investments of $2.8 billion in "oil-exporting countries" out of a world total of $50.7 billion, and in 1977 West Germany had direct investments of $1.0 billion in OPEC out of a world total of $22.8 billion. Year-end stock figures were not available for France, Japan, and Italy but investment flows to the Middle East were relatively small. OECD, *International Investment and Multinational Enterprise, Recent Trends in International Direct Investment,* Paris, 1981.

[19] The suppression is designed to avoid revealing confidential data about individual companies. The data are subject to surprising instability from year to year, and accounting reevaluations can affect changes in positions. For example, considering countries in the non-African part of the Middle East and not including Israel, the investment position of U.S. companies in OPEC countries plummeted by $655 million in 1981, while increasing almost tenfold in non-OPEC Middle East countries.

Table 24.—U.S. Direct Investment Position Abroad, Year-end 1981 (millions of dollars)

Country or region	Petroleum	Chemicals and allied products	Other manufacturing	Trade, banking, finance	Other industries	Total
Middle East (not including Israel):						
Egypt	934	8[a]	12	91	38	1,083
Libya	473	0	16	0	12	501
Other Saharan Africa	139	[a]	33	12	16	200
Other OPEC[b]	312	12	22	246	432	1,024
Other	362[c]	0	2	148[c]	17	529
Total	$ 2,220	$ 20	$ 85	$ 497	$ 515	$ 3,337
Other less developed countries:						
Israel	43[c]	15	147	180[c]	20	405
Latin America	4,499	3,719	12,043	14,371	4,252	38,884
Asia and Pacific	4,183	770	2,139	2,851	1,043	10,986
Sub-Saharan Africa[d]	1,187	96	283	321	612	2,499
Total	9,912	4,600	14,612	17,723	5,927	52,774
Developed countries	37,348	15,380	57,784	45,004	11,596	167,112
World total[e]	$52,107	$20,000	$72,481	$63,224	$19,533	$227,345

[a] The total for Egypt and other Saharan entered under Egypt.

[b] Saudi Arabia, Iraq, Iran, Kuwait, United Arab Emirates, and Qatar.

[c] Estimated as follows: rough division of the $128 million U.S. investment in trade subsidiaries in Israel and non-OPEC Asian Middle East ($70 million for Israel, $58 million for non-OPEC Asian Middle East), which was not disaggregated in the source in order to avoid disclosure of individual company data, allows us to disaggregate petroleum investment between the two for the purposes of this table.

[d] Does not include South Africa, which is included in developed countries.

[e] World total includes "international" petroleum and shipping investment of $799 million which cannot be allocated to individual countries.

SOURCE: Based on U.S. Department of Commerce, *Survey of Current Business*, August 1982, table 14, p. 22.

countries generally. Only 2.5 percent of total U.S. nonpetroleum direct investment in developing countries was in the Middle East. The Middle East's share of U.S. investment in LDC manufacturing subsidiaries was extremely small—one-half of 1 percent. This contrasts with the large Middle Eastern share of exports to LDCs (13 percent of industrial-country exports of manufactured goods to LDCs in 1980), and with the vast contracting effort that has been occuring in recent years.

The lack of foreign direct investment in the Middle East reflects manufacturing output's relatively small fraction of gross national product (GNP) for most of the countries in the region. Where direct investment is relatively large in developing countries, manufacturing is typically its largest destination. Direct investment in manufacturing in Egypt is practically nonexistent, despite the relatively high fraction of Egypt's GNP that comes from manufacturing, the strong bilateral relationship with the United States, and favorable Egyptian investment law.

Political risk, the lack of import barriers in most countries to stimulate domestic investment, small internal markets for many manufactured goods, and anticipated difficulties in technology transfer have all probably deterred manufacturing investment. The major exception to this is the Saudi petrochemical plants that are now starting to come into production. The availability of generous debt financing for joint venture partners, which reduced the amount of direct investment they were required to contribute to 15 percent in some Saudi Arabian joint ventures, was a powerful incentive.[20]

Most of the nonpetroleum direct foreign investment in the Middle East has been in subsidiaries in trade, banking, finance, and other industries, such as hotels and construction. Middle Eastern governments provide investment incentives to foreign firms willing to form partnerships with local firms.[21] Even in the chemical industry, which includes the petrochemical sector, little direct investment was recorded as of 1981. Table 25 shows that U.S. direct investments in the Middle East declined slightly in the early 1980's, in contrast to the pattern of increasing direct investment in other LDCs.

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[20] Oil entitlements have also been cited as an attraction to joint venture partners, but this was less of a benefit during the early 1980's when demand for oil fell.

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[21] The existence of such joint ventures may be the explanation of the significant direct investment position in "other industries" in the "other OPEC" countries (table 24). See discussion of plans to set up the National Industrialization Company in Saudi Arabia to promote joint ventures with local firms in "Saudi Arabia's NIC Seeks Foreign Partners," *Middle East Economic Digest*, Apr. 6, 1984, p. 45.

Table 25.—Change in U.S. Direct Investment Position Abroad, 1980-81

	Millions of dollars			
Country or region	Total position 1980	Total position 1981	Change 1980-81	Percent of 1980
Middle East (not including Israel):				
Egypt	$ 1,038	$ 1,083	$ 45	4.3%
Libya	575	501	−74	−12.9
Other Saharan Africa	190	200	10	5.3
Other OPEC[a]	1,679	1,024	−655	−39.0
Other	55	529	474	861.8
Total	$ 3,537	$ 3,337	−$ 200	−5.7%
Other less developed:				
Israel	$ 379	$ 405	$ 26	6.9%
Latin America	38,882	38,884	2	0
Asia and Pacific	8,505	10,986	2,481	29.2
Sub-Saharan Africa[a]	1,975	2,499	524	26.5
Total	$ 49,741	$ 52,774	$ 3,033	6.1%
Developed countries	$158,350	$167,112	$ 8,762	5.5%
World total[a]	$215,579	$227,345	$11,766	5.5%

[a] See notes for table 24.

SOURCE: U.S. Department of Commerce, *Survey of Current Business*, August 1982, tables 13 and 14, pp. 21-22.

SUPPLIER COUNTRY EXPORT SHARES IN MIDDLE EAST TECHNOLOGY TRADE

TRENDS IN INDUSTRIAL-COUNTRY EXPORT SHARES

Supplier shares of total exports of all industrialized countries to the Middle East have remained fairly stable in most cases during the past 12 years, despite changes in the oil economy, the exceptionally rapid expansion of Middle Eastern trade in the 1970's, and political conflicts and the shifting alliances in the region. For instance, according to tables 26 and 27, four of the principal suppliers had shares in industrial-country exports to 15 Middle Eastern countries, as follows, in 1970 and 1982:

	Total export shares (percent)	
	1970	*1982*
United States	*18*	*18*
West Germany	*15*	*15*
United Kingdom	*11*	*9*
Italy	*10*	*11*

In contrast, the shares of two other countries, France and Japan, did change steadily and markedly over the 12-year period. The

Table 26.—Industrial-Country Exports and Export Shares to the Middle East, 1982

	United States	Japan	West Germany	France	United Kingdom	Italy	Other industrial countries	Total value (millions)
Saudi Arabia	29.3	21.4	11.4	6.4	7.7	8.0	15.8	$30,820
Egypt	30.1	6.9	12.0	10.4	6.2	8.7	25.7	9,557
Iraq	6.0	19.5	22.2	10.2	10.8	11.8	19.5	14,105
Iran	2.0	15.6	23.2	5.5	9.6	12.0	32.2	6,031
Algeria	11.1	8.3	16.5	25.9	4.2	8.1	25.9	8,198
Kuwait	15.9	30.2	13.8	5.3	8.9	10.6	15.2	5,908
6 countries	***19.7%***	***18.0%***	***15.2%***	***9.6%***	***8.0%***	***9.3%***	***20.1%***	***74,619***
Libya	5.1	4.8	25.7	7.2	7.7	36.0	13.6	5,952
Oman	10.3	27.3	9.6	4.5	27.4	5.2	15.7	1,680
Qatar	9.8	22.1	9.6	12.1	27.5	5.0	13.9	1,564
UAE	17.2	23.3	11.3	8.5	15.3	9.2	16.4	6,403
Jordan	22.8	9.2	14.8	6.3	18.9	11.6	16.4	2,714
Lebanon	13.3	7.2	11.1	15.1	5.3	22.3	25.6	2,209
Syria	8.3	10.2	22.0	12.0	9.4	14.4	23.6	1,663
North Yemen	4.5	22.6	12.4	14.2	10.9	12.5	23.0	847
South Yemen	2.1	22.9	4.6	9.3	16.0	14.4	30.7	388
15 countries	***17.9%***	***17.2%***	***15.4%***	***9.5%***	***9.4%***	***11.2%***	***19.5%***	***$98,039***

NOTE: Supplier shares calculated on the basis of total industrial-country exports to the Middle East countries listed.

SOURCE: International Monetary Fund, *Direction of Trade Statistics Yearbook*, 1983.

shares of the two countries were as follows in 1970 and 1982:

	Total export shares (percent)	
	1970	*1982*
Japan	*10*	*17*
France	*17*	*9*

Changes in supplier country export shares were more noticeable for machinery equipment exports to the Middle East:

	Machinery and equipment export shares (percent)	
	1970	*1982*
United States	*23*	*20*
West Germany	*23*	*22*
United Kingdom	*16*	*9*
Italy	*10*	*14*
Japan	*9*	*23*
France	*18*	*9*

This calculation of supplier shares is based on total exports for the six major suppliers only. In machinery and equipment exports, a decline in the position of the United Kingdom and an improvement in Italy's position occurred during the period.

These changes in share for Japan and France are related to events that probably have run their course. In the case of Japan, the expansion in exports to the Middle East follows the striking expansion of Japan's exports to the world in general. Japan's relative earlier neglect of export markets of all but the major countries of the distant Middle East changed to greater interest because of the increase in the size of the regional market, Japan's official desire to redress bilateral trade imbalances and develop relations with oil suppliers, and the improvement of global communications and transportation. The increased importance that Japan's government and private sectors placed on the Middle East following the oil "shock" of 1973 was matched by a substantial increase in both commercial and government presence. On the commercial side, trading companies opened new branch offices, and on the government side, high level official delegations visited various capitals and helped negotiate large contracts. In this way, Japan developed a competitive position in the Middle East fully consistent with its worldwide position. With the removal of the Middle East as an exception to Japan's world trading pattern, the factors that affect Japan's worldwide export share—the rate of growth of the Japanese economy, the government's general export promotion policies, the pattern of Japan's comparative advantage, and the value of the

Table 27.—Industrial-Country Exports to the Middle East—Market Share for Selected Years (percent)

	United States	Japan	West Germany	France	United Kingdom	Italy
1981						
Saudi Arabia	27	23	12	7	8	8
Iran	4	19	20	9	9	10
Algeria	8	5	14	27	5	16
Egypt	29	1	15	14	7	11
Iraq	7	23	22	11	9	10
Kuwait	18	30	11	4	11	9
Total 6 countries	17	19	15	11	8	10
Total 15 countries	16	18	14	10	9	14
1980						
Saudi Arabia	25	23	11	7	8	9
Iran	0	20	20	9	12	7
Algeria	6	5	16	30	4	15
Egypt	26	6	13	14	8	9
Iraq	7	23	19	11	8	10
Kuwait	0	28	12	5	12	8
Total 6 countries	15	19	12	12	8	10
Total 15 countries	14	17	14	11	8	12
1975						
Saudi Arabia	30	27	11	9	9	6
Iran	28	16	19	6	10	5
Algeria	13	5	12	39	4	11
Egypt	22	7	14	14	8	12
Iraq	8	20	26	10	7	6
Kuwait	21	22	12	6	13	7
Total 6 countries	22	16	16	12	8	7
Total 15 countries	20	15	16	12	9	10
1970						
Saudi Arabia	26	16	12	5	15	6
Iran	23	13	23	5	11	6
Algeria	6	2	10	55	4	9
Egypt	13	2	21	11	6	11
Iraq	8	6	7	13	21	6
Kuwait	16	24	11	8	18	7
Total 6 countries	16	10	16	19	11	8
Total 15 countries	18	10	15	17	11	10

NOTE: Supplier shares calculated on the basis of total industrial country exports to the Middle East countries listed in table 26.

SOURCE: Compiled for the Office of Technology Assessment, from International Monetary Fund, *Direction of Trade Yearbook*, various issues.

yen—will be key factors influencing Japan's Middle East trade.

In the case of France, the decline in its export share to the Middle East was almost entirely caused by the steady decrease in its share of the postcolonial Algerian market from 55 percent in 1970 to 27 percent in 1981 (see table 27). Its exports to Algeria in that year also dropped to 24 percent of its exports to the 15-country region. Given the historical relationship between France and Algeria, within which French firms have developed significant market presence, there should be no simple expectation that the decline in the French share in Algeria will continue. Some further reduction in the French share of the Algerian market may take place, but in view of the decreased importance of the Algerian market to France, it is unlikely to have a large impact on France's regionwide share.

In the past decade, to reiterate, the overall shares of most countries have been relatively stable and those that have changed significantly have done so for reasons that are not likely to persist. Nevertheless, a number of changes in bilateral political relationships did have effects on bilateral trade in the last decade.

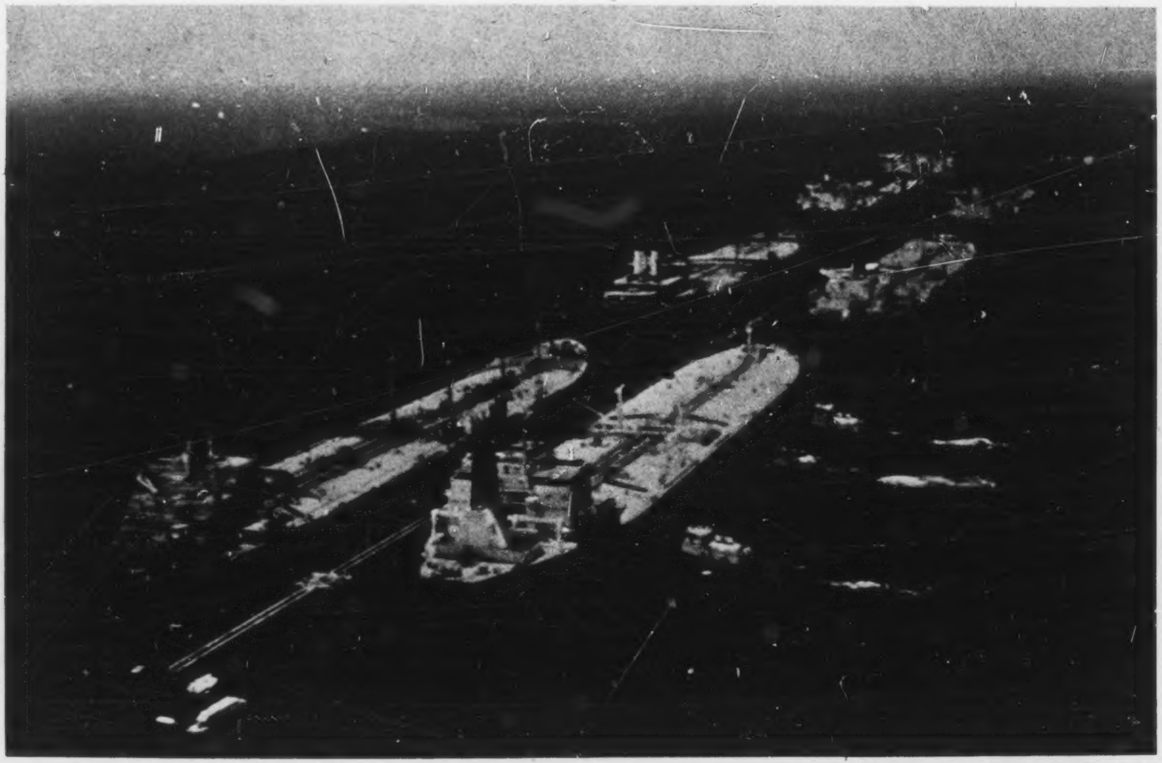

Photo credit: Aramco World Magazine

Ras Tanura Marine Port, Saudi Arabia. Oil exports provide Saudi Arabia with revenues to finance imports of technology and services from supplier firms around the world

For example, the U.S. export share to Egypt went from 13 percent in 1970 to 31 percent in 1974, and the U.S. export share to Iran went from 24 percent in 1978 to zero in 1980. Similar gyrations in shares have affected bilateral U.S. trade with Iraq, Libya, Syria, and Algeria at various times. Nevertheless, diversification within the "portfolio" of export opportunities resulted in substantial stability in the U.S. market share in the Middle East region. Even the complete cessation of exports to Iran after 1979 only reduced the U.S. 15-country share from 18 percent in 1978 to 14 percent in 1980. By 1982, the U.S. share had recovered to 18 percent.[22] These developments were strongly influenced by U.S. superpower status and strong U.S. political positions in the Arab-Israel dispute. Therefore, despite overall stability of U.S. export shares, there has been striking variation in particular country markets which has been affected by political factors.

The experience of other industrial countries over the period was similar to that of the United States in the overall stability of their regional export shares, despite some shifts in particular country markets, such as West Germany's growing share in Iraq or the volatility of Japan's share in Iran. Year-to-year country changes in share for the other industrial countries usually varied gradually. As a rule, countries with dominant trading positions in former colonies or protectorates have seen these positions deteriorate (although they are still

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[22] The U.S. overall share reached a high of 20 to 22 percent in the 1974-77 period.

Photo credit: Perry Ketchum

Algerian port. France and Algeria have been important trading partners, with the Mediterranean Sea offering a convenient shipping route

strong). This has been true of France in Algeria and the United Kingdom in the Gulf countries. Table 27 presents export shares for supplier countries in various Middle Eastern countries and country groups in selected years.

PRODUCT EXPORT SPECIALIZATION OF MAJOR SUPPLIER COUNTRIES

Export shares by product category show a significant degree of supplier specialization. Table 28 gives the market shares of the six major industrial countries by product category in 1978 and 1982. Similar tables for six Middle Eastern countries are presented in appendix tables 4A-4F. From these tables it can be seen that the United States, Italy, and France had large shares in food and other raw material exports. All the major West European countries (except Italy in 1982) exported larger shares of chemicals to the Middle East than did the United States and Japan, probably because of transportation cost differentials. In 1978, Japan and Italy were relatively strong in basic and other manufactures. By 1982, however, Italy's share of the combined category of basic and other manufactures had declined substantially.

In the machinery and equipment category, certain specializations emerged in the export data for the Middle East: Japan was the dominant supplier of consumer electronics and road vehicles in both 1978 and 1982. Japan also gained the largest overall market share in machinery and equipment exports in 1982.

In 1978, West Germany and the United States were clearly the most important exporters of production machinery (SITC 71 and 72),[23] but Japan, France, the United Kingdom, and other OECD countries were all significant exporters of production machinery as well. In 1982, both the United States and Japan in-

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[23] Standard International Trade Classification.

Photo credit: U.S. Agency for International Development

Port of Alexandria, Egypt

creased their shares relative to West Germany in both nonelectric and electric machinery. West Germany, which in 1978 had the highest share in both categories, relinquished first place in 1982 to the United States in nonelectric machinery and to Japan in electric machinery. Except for Italy, all of the major industrial countries participated significantly in telephone and other nonconsumer telecommunications equipment exports, judging by 1978 and 1980 data.[24]

Table 28.—Supplier Export Shares to the Middle East by Commodity Class, 1982, 1978 (15 Middle East Countries[a]—6 Major Industrial Countries[b])

SITC Commodity Code	United States	Japan	West Germany	France	United Kingdom	Italy	Total
1982							
0-4—Raw materials	31.4%	3.5%	10.2%	19.0%	11.2%	24.8%	$ 7,870
5—Chemicals	15.2	5.4	24.7	20.1	24.3	10.2	3,534
6—Basic manufactures	13.2	40.5	18.1	14.6	9.6	3.9	12,998
7—Machinery and equipment	20.3	23.5	22.8	9.4	9.6	14.4	42,070
71—Nonelectric	30.0	21.0	21.6	11.4	13.8	2.2	13,945
72—Electric	15.3	26.0	15.7	11.7	11.7	19.6	10,394
724—Telecommunications	13.6	43.5	13.9	13.6	15.3	0.1	2,358
726—Electrical medical	25.5	10.7	33.1	15.9	9.9	5.0	144
73—Transport	19.0	29.3	29.3	7.9	6.1	8.4	14,523
732—Road vehicles	12.8	36.3	35.3	7.1	5.8	2.7	10,819
734—Aircraft	63.0	0.7	.0	13.4	7.7	15.2	1,810
8—Other manufactures	17.8	23.9	14.7	13.5	13.9	16.1	5,120
861—Professional scientific instruments	22.0	22.9	20.5	14.9	18.3	1.3	895
9—Other	4.8	1.6	13.7	0.5	25.4	54.0	2,223
Total	19.3%	22.9%	19.9%	11.9%	11.2%	14.8%	$73,816
1978							
0-4—Raw materials	44.8	2.0	9.7	20.0	10.7	12.9	$ 3,605
5—Chemicals	14.0	6.1	24.0	17.5	22.6	15.8	2,566
6—Basic manufactures	9.9	33.6	17.2	11.1	10.2	18.0	11,046
7—Machinery and equipment	21.2	21.9	24.4	11.1	12.9	8.6	28,456
71—Nonelectric	21.7	16.4	26.6	11.9	13.2	10.2	12,100
72—Electric	17.9	23.1	27.2	10.4	13.5	8.0	7,551
724—Telecommunications	19.0	35.4	15.1	10.8	15.8	3.8	1,918
7249—Telecommunications, n.e.s.	26.7	14.2	17.1	14.9	22.0	5.2	1,354
726—Electrical medical	23.3	7.3	38.2	9.4	14.3	7.5	83
73—Transport	23.4	28.4	18.8	10.5	11.9	7.0	8,805
734—Aircraft	55.3	1.3	1.3	7.2	22.9	12.0	1,482
7349—Aircraft parts	63.3	0.1	1.6	8.2	17.8	9.0	545
8—Other manufactures	10.3	18.6	12.9	11.0	16.4	30.7	3,797
Total	22.7%	20.7%	19.8%	11.4%	12.7%	12.7%	$53,365

[a] Saudi Arabia, Iran, Algeria, Egypt, Iraq, Kuwait, Libya, United Arab Emirates, Syria, Lebanon, Jordan, Qatar, Oman, North Yemen, South Yemen.
[b] United States, Japan, West Germany, France, United Kingdom, Italy, only.

SOURCE: **1982:** Organization for Economic Cooperation and Development, Trade Series C, Data Resources, Inc., data bank; **1978:** United Nations, "Trade With Industrial Countries," supplement to the *World Trade Annual*.

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[24] For 1978 data, see table 28. 1980 supplier shares of telecommunications, n.e.s., the category that includes equipment for communications systems, are as follows: United States (18.0 percent), Japan (12.5 percent), West Germany (17.8 percent), France (23.6 percent), United Kingdom (21.9 percent), Italy (6.2

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Some other machinery and equipment specializations were notable. The United States was the dominant supplier of aircraft and parts in both years. All the industrial countries, except Italy, were strong in instruments in 1982. Finally, Italy had a specialization in office equipment exports.

CONTRACTING SPECIALIZATION OF SUPPLIER COUNTRIES

Because of the incomplete coverage[25] of the data on contracts, and because the magnitude of many of the individual contracts lends instability to the data from year to year, the data presented in table 29 support only limited judgments about supplier shares and about their significance. Four major suppliers—the United States, Japan, West Germany, and France—had about equal shares of the overall MEED contract data totals for 1979-82. In addition, the United Kingdom and Italy together had a share about equal to one of the leading countries. The United States had a smaller 4-year contracts share than the other three leading countries.[26]

Ideally, OTA would carry out detailed analysis of the components of these contracts to estimate the benefits to the various supplier countries—e.g., to determine the employment supported by these contracts in the various home countries. Unfortunately, the contract data do not generally include information concerning subcontractors, or other detailed data below the prime contract level.

Trade data indicate that the United States exports large amounts of machinery and equipment to the Middle East. The value of machinery and equipment exports ($8.5 billion) in 1982, for instance, was larger than that of 1981 reported contracts awarded to U.S. firms.[27] This suggests that prime contracts of other countries were serviced by large amounts of U.S. machinery. The contract data may, therefore, underestimate the underlying U.S. share of contract expenditure.

CONTRACTING SPECIALIZATION OF SUPPLIER COUNTRIES IN FOUR TECHNOLOGY SECTORS

The picture changes substantially when one examines contracts in the four technology sectors examined in depth in this report. Table 30 indicates that the United States was the dominant contractor country for the four-sector total, with 44 percent of the total identified contract amounts of $19.7 billion going to the major industrial countries. This was true of all three types of contracts as well—technical services, equipment supply, and construction.

The United States was particularly dominant in technical services, as indicated by data presented in table 31 which examines the four sectors individually. U.S. contractors had 42, 96, and 78 percent, respectively, of the technical service contracts in communications, aircraft support systems, and medical services.[28]

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percent). In both 1978 and 1980, smaller industrial countries as a group, notably the Netherlands and Sweden, also exported significant shares of telecommunications, n.e.s. equipment to the Middle East—17.9 percent of the total for industrial countries in 1978 and 36.5 percent in 1980.

[25] The major source of contractor data used here is *Middle East Contracts*, MEED Consultants, London, annual issues for contract years since 1979. MEED relies on voluntary reports of contracts and on information from correspondents. As discussed in chapter 2, small contracts may be missed and certain country data may be unreliable. A further source of difficulty is that joint venture contracts with various Western suppliers may be attributed to local contractors. In this case it also is impossible to determine the nationality of the international contractor.

[26] Supporting the judgment that the United States has not been the leading prime contractor during the past few years is the expectation that unreported Iraqi data would not be likely to favor the United States if they had been included. On the other hand, some local Middle East companies receiving about one-fourth of contract awards in 1982 were joint ventures with industrial-country firms, and some of these undoubtedly involved U.S. firms particularly in Saudi Arabia where most of the contracts were awarded. There is no way to determine whether or not U.S. firms play a disproportionately large role in these joint ventures, although the direct investment data presented above suggest that they do.

[27] There would be a lag between contract award and machinery import, so 1981 contract awards should be compared to 1982 machinery imports.

[28] This is not to suggest that the United States is dominant in services exports in general. 1980 International Monetary Fund data, as compiled by the Office of the U.S. Trade Representative, show that the United States was only fourth in services exports worldwide other than transportation, travel and tourism: West Germany ($15.5 billion), United Kingdom ($13.3 billion), France ($12.8 billion), and United States ($10.8 billion). (Source: Office of the U.S. Trade Representative, *U.S. National Study on Trade in Services*, December 1983, table 3, p. 114.

Table 29.—Supplier Shares of Middle East Contracts, 1979-82[a]

Supplier	1979	1980	1981	1982	Total 4 years
Total amount[b] (billions of dollars)	$41.1	$36.2	$67.6	$40.8	$185.7
Six major industrial countries	70.7%	57.5%	57.2%	52.8%	59.3%
South Korea	9.1	12.0	13.4	16.5	12.9
East Europe	4.3	4.8	9.3	4.0	6.2
Local and Middle East	15.9	25.7	20.0	26.7	21.7
Total	100.0	100.0	100.0	100.0	100.0
Six major industrial countries (billions of dollars)	$29.1	$20.8	$38.7	$21.5	$110.1
United States	22.9%	11.2%	17.1%	15.8%	17.2%
Japan	23.5	16.1	19.1	25.4	20.9
West Germany	17.2	14.6	22.8	11.6	17.5
United Kingdom	9.3	11.7	7.8	16.1	10.5
France	20.1	32.1	17.6	20.1	21.5
Italy	7.0	14.3	15.6	11.0	12.3
Total	100.0	100.0	100.0	100.0	100.0

[a] Contracts were awarded in a range of categories including, above $5 billion in 1981, defense, housing, industry, marine, petroleum, and roads and railways. Smaller total contract amounts were awarded in agriculture, aviation, education, health, urban development, public buildings, telecommunications, tourism, vehicles, and water.

[b] This total is for contracts identified by contractor's home country. Joint venture companies are characterized according to place of registration; consortia allocations have been divided proportionally. Countries or country categories not listed are not included in total.

SOURCE: MEED Consultants, *Middle East Contracts—Directory and Analysis*, 1982 second half, p. 9.

Table 30.—Supplier Share of Middle East Contracts in Four Technology Sectors, Aggregated, By Type of Contract,[a] 1978-82

	Type of contract			
Supplier	Technical services	Equipment supply	Construction	Total
Total amount (billions of dollars)	$4.4	$10.8	$13.6	$28.8
Six major industrial countries	46.1%	69.1%	76.1%	68.9%
Other	23.2[b]	30.3[c]	16.2	22.5
Local and Middle East	30.7	0.6	7.6	8.5
Six major industrial countries (billions of dollars)	$2.0	$ 7.4	$10.3	$19.7
United States	75.5%	37.2%	43.6%	44.4%
Japan	3.4	16.5	7.9	10.7
West Germany	2.8	10.2	7.0	7.8
United Kingdom	16.3	11.6	1.5	6.8
France	0.2	21.5	30.9	24.3
Italy	1.9	2.9	9.1	6.1
Total major industrial countries	100.0%	100.0%	100.0%	100.0%

[a] Communications, commercial aircraft support systems, medical services, and petrochemical facilities. Incomplete coverage, especially for 1978-79 and 1982.

[b] Comprised entirely of one large Canadian communications technical services contract (Bell of Canada).

[c] Comprised primarily of a few Sweden/Netherlands telecommunications equipment contracts.

SOURCE: Office of Technology Assessment. A detailed compilation of the contracts by supplier firms and awarding Middle Eastern countries for the 1978-82 period is available from OTA upon request.

Table 31.—Supplier Shares of Middle East Contracts in Four Technology Sectors, By Type of Contract,[a] 1978-82 (percent or millions of dollars)

Technology sector/ supplier country	Type of contract Technical services	Equipment supply	Construction	Total
Communications				
Major industrial countries	$266.9	$6,079.6	$167.7	$6,514.1
United States	42.0%	44.6%	1.0%	43.4%
Japan	8.4	10.0	79.4	11.7
West Germany	20.2	11.8	—	11.9
United Kingdom	15.2	12.2	—	12.0
France	0.2	19.3	19.6	19.0
Italy	14.1	1.6	—	2.1
Total	100.0%	100.0%	100.0%	100.0%
Commercial aircraft support systems				
Major industrial countries	$462.7	$488.7	$2,873.8	$3,825.3
United States	96.3%	0.2%	6.5%	16.5%
Japan	—	2.3	2.6	2.3
West Germany	0.3	3.5	20.4	15.8
United Kingdom	2.8	15.8	3.5	5.0
France	0.6	77.1	67.0	60.3
Italy	—	1.0	—	0.1
Total	100.0%	100.0%	100.0%	100.0%
Medical services				
Major industrial countries	$1,231.1	$44.7	$2,841.9	$4,117.7
United States	77.8%	56.0%	6.4%	28.3%
Japan	—	4.1	21.4	14.8
West Germany	—	—	4.4[a]	3.0
United Kingdom	22.2	39.9	1.6	8.2
France	0.1	—	43.5	30.1
Italy	—	—	22.7	15.7
Total	100.0%	100.0%	100.0%	100.0%
Petrochemical facilities				
Major industrial countries	$45.0	$883.8	$4,429.2	$5,358.0
United States	—	—	93.1%	76.9%
Japan	100.0%	67.6%	—	12.0
West Germany	—	2.1	0.2	0.5
United Kingdom	—	17.5	—	2.9
France	—	—	—	—
Italy	—	12.8	6.7	7.7
Total	100.0%	100.0%	100.0%	100.0%

[a] It appears that West German firms received a number of sizable hospital construction contracts. Contract values were not available, however.

SOURCE: Office of Technology Assessment.

The telecommunications figure would undoubtedly be higher if American participation in the large 1978 Bell of Canada technical services contract in Saudi Arabia were given weight.

In petrochemicals, technical service contracts were not reported separately to any extent. Nevertheless, a large component of technical services is undoubtedly included in the large U.S.-dominated petrochemical construction contracts. All this supports the hypothesis that the United States has had a comparative advantage in the sale of technical services in the Middle East that matches the comparative advantage it has in human capital-intensive trade in general.

No such suggestion of a general comparative advantage in equipment supply can be gleaned from the four-sector contract data. U.S. contractors did well in telecommunications and medical equipment supply, but France and Japan were dominant in supply of equipment for aircraft support and petrochemical facilities, respectively. Except for the petrochemical construction contracts, U.S. contractors were awarded very few construction contracts during the period under review. French contractors did well in airport and hospital construction, and Japanese contractors won all of the identified communications construction contracts, except for a small amount won by French contractors.

It is hard to generalize about contracting in the Middle East from the experience in the four technology sectors because supplier shares in the four sectors were substantially different from those in contracts as a whole. However, OTA has framed the hypothesis that in technology sectors where transfer of technology is difficult, where technology is transferred in packages overseen by expatriate technical and managerial experts, and where because of these factors, unbundling of certain components is difficult, U.S. contractors have had a comparative advantage.

In individual cases, this advantage may, of course, be overridden by the superior performance of companies from other supplier countries, by political factors, or by price differentials arising from supplier subsidization or exchange-rate misalignments rather than from long-run comparative advantage. Nevertheless, the evidence suggests that U.S. companies have been preeminent in the Middle East in technical services and other difficult technology transfer tasks in the recent past. OTA's evidence is largely from the four technology sectors examined and is not conclusive, but it is consistent with what is known about U.S. comparative advantage generally.

Another hypothesis suggested by the contract data in the four technology sectors is that U.S. contractors won at least some of the equipment supply and construction contracts when the equipment and construction tasks could not easily be unbundled from the technical services in the package. The large petrochemical contracts and the Litton Industries contract to install a national communications system in Saudi Arabia may be examples of this. On the other hand, according to this hypothesis, suppliers from other countries would be more likely to win contracts to supply standardized airport equipment, such as radar systems.

In certain contexts (e.g., medical equipment), where, presumably, much of the large-ticket equipment items could be unbundled (and perhaps are at the subcontract level), U.S. equipment sales may have come more as a result of the high quality of equipment.

FACTORS AFFECTING SUPPLIER SHARES

General Determinants of Exporter Shares

Two fundamental determinants of exporter shares and of change in shares are the sizes of the exporting economies and their rates of growth. Large countries tend to have smaller ratios of exports to GNP, since internal trade opportunities are greater for a given firm in a large country than in a small one. This factor provides an underlying reason why the U.S. share of exports to the Middle East is smaller than its share of industrial-country GNP.

As an economy grows, a country's trade can generally be expected to grow as well, with faster growing countries tending to increase their trade faster than slower growing ones. This is an underlying reason why Japan, with a relatively fast growing economy, has increased its share of both world and Middle Eastern trade.

Beyond these very general factors are a variety of other factors that determine the overall export share of a country and how it changes over time. Natural and artificial barriers to trade (shipping costs to the Middle East and the boycott against firms trading with Israel) and natural and artificial incentives to trade (Japan's complete lack of domestic petroleum resources and favorable tax treatment for exporters) affect a country's overall export share in the world and in particular countries.

Regarding supplier shares of particular commodities in Middle Eastern trade, countries tend to have higher shares in those commodities in which they have a comparative advantage—i.e., in commodities produced by their relatively more efficient industries. As discussed in chapter 2, the United States has comparative advantage in research and development (R&D) intensive and human capital-intensive goods and services and a comparative disadvantage (relative to West European countries and Japan) in standardized machinery and manufacture. A study covering the period 1970-78, which examined 73 manufactured commodity classes, concluded that the U.S. comparative advantage continued in technology-intensive exports over the period.[29]

Comparative advantage differences among the industrial countries should not be overemphasized, however. All the larger industrial countries have well diversified economies and are able to compete with one another in a wide variety of export markets. The competitive differences among firms of a given country may be larger than those among firms of different countries, especially if all governments subsidize their exporters. Furthermore, political factors may overshadow comparative advantage in particular contexts.

Middle Eastern Regional Shares

Table 32 shows that exporter shares of Middle Eastern regional trade are sometimes heavily dependent on trade with individual countries. The United States had fully two-thirds of its 1982 Middle Eastern trade with just two countries, Saudi Arabia and Egypt, and half of its trade with Saudi Arabia alone. All but France had Saudi Arabia as its major trading partner, but no supplier country's trade was more heavily concentrated there than that of the United States. If Saudi Arabian imports decline or if the United States significantly loses market share there, its overall Middle Eastern share could decline substantially.

Other trade concentrations above 15 percent in 1982 included Japan and all the West European countries with Iraq; France with Algeria; and Italy with Libya. Except for changes involving these countries, in most cases even large changes in trade or share would result in little change in regional share. The case of Iran is a partial exception; large changes in trade are possible with the end of the Iraq-Iran War, as is a large change in the U.S. export share. Both of these changes could result in significant changes in supplier regional shares.

Major Specific Factors in Export Competition in the Middle East

The major specific factors affecting supplier export shares in the Middle East market appear to be a set of factors affecting price; a set of factors involving bilateral relations, historical presence, and diplomatic support; and, finally, the industry standing of the competing firms.[30]

Price.—OTA's market share data in the four technology sectors examined indicate that, for the levels of quality demanded, U.S. firms tend to be price competitive in the items in which the United States has a comparative advantage, namely in managerial and technical services and in R&D/human capital-intensive commodities. This advantage is matched by some price disadvantage in standardized equipment and services.

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[29] Raymond F. Mikesell and Mark G. Farah, *U.S. Export Competitiveness in Manufacture in Third World Markets* (Washington, D.C.: Center for Strategic and International Studies, Georgetown University, 1980), p. 106ff.

[30] Two other factors, the use of local agents and the design of training programs, have been mentioned as important factors in winning contracts and making sales. They do not appear to be important determinants of export share, however. The use of local agents has been an important, sometimes required means of competing for contracts throughout the Middle East, particularly in Saudi Arabia and Kuwait, but since suppliers widely use local agents, it does not seem to be a factor that differentiated suppliers of different countries.

The strategy particularly favored by the Saudi Arabian Government in recent years to engage international suppliers in joint venture with local firms also does not appear to have been an important factor affecting supplier shares, except for the large petrochemical projects in Saudi Arabia, since the aggregate value of direct investment outside of trade and financial enterprises has been small.

In all sectors examined, Middle Eastern countries usually require contract proposals to incorporate programs to train nationals to eventually take over the operational responsibilities of the foreign firm. OTA has seen no evidence, however, that any country's exporters have an advantage in training per se beyond their expertise in particular types of technologies.

Table 32.—Percentage Distribution of Supplier Trade With Middle East Countries, 1982

	United States	Japan	Germany	France	United Kingdom	Italy
Saudi Arabia	51.4%	39.2%	23.4%	21.2%	25.8%	22.3%
Egypt	16.4	3.9	7.6	10.7	6.4	7.6
Iraq	4.8	16.3	20.8	15.6	16.5	15.1
Iran	0.7	5.6	9.3	3.6	6.3	6.6
Algeria	5.2	4.0	9.0	22.9	3.8	6.0
Kuwait	5.4	10.6	5.4	3.4	5.7	5.7
Total 6 countries	83.9%	79.6%	75.4%	77.4%	64.5%	63.3%
Libya	1.7	1.7	10.1	4.6	5.0	19.5
Oman	1.0	2.7	1.1	0.8	5.0	0.8
Qatar	0.9	2.1	1.0	2.0	4.7	0.7
UAE	6.3	8.8	4.8	5.8	10.6	4.8
Jordan	3.5	1.5	2.7	1.8	5.6	2.9
Lebanon	1.7	0.9	1.6	3.6	1.3	4.5
Syria	0.8	1.0	2.4	2.2	1.7	2.2
North Yemen	0.2	1.1	0.7	1.3	1.0	1.0
South Yemen	0.0	0.5	0.1	0.4	0.7	0.5
Total 15 countries	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

SOURCE: International Monetary Fund, *Direction of Trade Statistics Yearbook, 1983.*

Price can be affected in other ways, however. For long-lived items, export credit subsidies are one way. Direct subsidization of production or of exports, assumption of risk in cost or political insurance, and, more subtly, industrial policy support of R&D are other ways governments can affect the prices their firms charge. In each of these cases, the subsidies or other factors may prevent a given country's firms from competing profitably. All of these factors affecting price appear to be significant factors affecting exports to the Middle East.

Of the major industrial-country exporters, France in particular, and to a certain extent the United Kingdom and Italy, have subsidized exports. None of the other countries eschew this entirely, however. The United States has been taken to task over what have been called industrial policy subsidies to the aerospace industry and for the tying of bilateral assistance to the purchase of American goods—to Egypt—e.g., for telecommunications. These issues are analyzed more fully in chapters 12 and 13.

Bilateral Relations, Historical Presence, and Diplomatic Support.—During the period under review, governments affected sales to the Middle East in several ways. Perhaps the most dramatic trade effects have been those occurring when political relations are frigid. For example, U.S. trade relations with Iran, Libya, and Iraq have during the past decade been negatively affected by political differences. Commercial relations then tend to fall by the wayside but can be repaired, as the case of the United States and Egypt demonstrates. Japan, West Germany, and Italy have been able to "sell to all," with the United States and France more strongly linking political and economic relations.

In another example, antiboycott and overseas business regulations, since they apply to U.S. exporters across a broad span of business activity, probably reduced the U.S. export share at least by a small amount. U.S. national security, foreign policy, and nonproliferation controls appear to have had an impact on supplier shares in aircraft and nuclear sales during the 1970-82 period.

On the other hand, extremely close political relations between a supplier and a recipient country may be followed by a period in which the recipient attempts to diversify. The secularly declining share of French suppliers in Algeria during 1970-82 and the recent trends in diversification away from dependence on U.S. contractors in Saudi Arabia appear to fit this pattern.

The historical presence of firms in certain countries, such as the ARAMCO set of firms in Saudi Arabia, is sometimes an important factor in current commercial success. The petrochemical ventures involving these firms illustrate this point.

The importance of diplomatic support of exporters is difficult to determine. When the diplomatic support extends to government financial and performance guarantees, however, it may be a decisive factor, as has been the case in contract awards in the medical services sector in the Middle East. High-level economic diplomacy on the part of supplier governments has been an asset to supplier firms in some contract awards, as documented in the medical service, telecommunications, and commercial airlines sectors and discussed in chapters 7, 8, and 9.

Industry Standing.—Finally, an important factor in a number of contract awards during the period 1970-82 was the industry standing of the firm. Industry standing refers to the proven track record of a firm and the length of its experience with a particular type of technology transfer. Particularly when the firms bidding for contracts are inexperienced (new entrants in the market) or risk-averse, strong industry standing for the prime contractor or the consortium leader can be an extremely important factor. In the hospital management subsector of management services, the strong reputation of U.S. firms has undoubtedly been an asset in winning contracts; in sales of medical equipment, however, firms from many West European nations have gained industry standing and U.S. firms have not fared as well in sales. In a situation where all firms bidding have industry standing and the contracting groups in the Middle East are comparatively experienced, industry standing is not as important. Sales of commercial aircraft fall into this category, as evidenced by the Boeing-Airbus competition.

CONCLUSION

Trade with the Middle East has been big business for the Western industrial countries, with exports to the region in 1982 in the range of 8 to 12 percent of total exports for five of the industrial countries. During the past decade industrial-country trade with the Middle East expanded more rapidly than trade with any other region of the developing world.

Technology trade, insofar as this is measured by imports of machinery and equipment or by large contracts, has been a large component of Middle Eastern imports. These imports were principally destined for use in physical and social infrastructure projects in the oil-rich countries. Direct investment outside the petroleum sector was not a major mechanism of technology transfer in the Middle East during the last decade.

Saudi Arabia has been by far the largest market of the 15 countries in both trade and contracts, purchasing in recent years about one-quarter of all industrial-country exports to the region, one-third of all machinery and equipment exports, and one-third to one-half of the value of all contracts. At various times in the last decade, the Saudi position has been rivaled by Iran and Iraq in one or the other of these categories, but political instability and war reduced their imports of civilian technologies. Saudi Arabia has also been among the top ten export customers worldwide for many of the industrial countries. It was the sixth largest customer of the United States in 1982, for example.

No clear trend was apparent in the export shares of the major industrial country suppliers, despite the context of political turmoil, oil crisis, and rapid growth of trade in the region. The United States, in particular, because of political differences, has seen its trade vanish in certain countries like Iran. Nevertheless, over the region as a whole, four of the major exporting countries—the United States, West Germany, the United Kingdom, and Italy—maintained their overall export positions through the decade (despite variations in particular types of exports or markets). Japan and France exchanged share positions, with Japanese firms dramatically expanding export shares while French firms lost ground.

The share of U.S. firms in contracting in the region was similar to that of the United States in total exports—18 percent in total exports and 16 percent in contracts in 1982. However, for the four technology sectors examined in this chapter—telecommunications, aircraft support systems, medical services, and petrochemical facilities—the U.S. share for 1978-82 contracts was 44 percent. This higher market share in these advanced technology sectors confirms the view that the United States has a comparative advantage in R&D and human capital-intensive trade.

CHAPTER 4 STATISTICAL APPENDIXES

Appendix Table 4A.—Supplier Export Shares to Saudi Arabia, by Commodity Class, 1982

Commodity	SITC[a]	United States	Japan	Germany	France	United Kingdom	Italy	Total value = 100 percent ($ millions)
		(percent)						
Food and live animals	0	43.4	3.2	10.5	26.4	15.7	0.8	1,032
Beverages and tobacco	1	36.6	28.6	0.5	0.8	22.9	10.6	322
Crude materials	2	71.1	2.9	5.4	12.1	6.6	2.0	69
Mineral fuels	3	8.5	0.2	0.8	26.5	4.3	59.7	486
Oils and fats	4	73.4	1.0	10.6	6.5	6.0	2.6	30
Chemicals	5	29.1	4.1	15.4	13.5	31.2	6.6	949
Manufactured, classified by material	6	22.7	45.1	11.3	10.3	9.1	1.4	4,739
Machinery and equipment	7	32.8	27.7	17.9	5.4	8.1	8.2	13,757
Machinery, other than electric	71	42.7	21.3	14.4	7.4	13.2	1.0	4,850
Electrical machinery	72	29.9	28.0	16.0	8.0	7.9	10.2	3,405
Telecommunications apparatus	724	25.6	51.1	12.4	4.7	6.2	0.0	658
Electrical, medical and radiological	726	40.7	7.9	37.4	1.5	9.3	3.3	45
Transport equipment	73	30.4	39.1	21.2	2.3	4.3	2.6	4,676
Road motor vehicles	732	21.0	48.7	24.7	1.8	2.9	0.8	3,687
Aircraft	734	81.6	2.1	0.0	1.8	11.3	3.3	620
Miscellaneous manufactured goods	8	27.5	24.2	10.7	9.9	10.4	17.3	2,014
Instruments and apparatus[b]	861	35.5	29.8	11.0	10.4	12.2	1.0	301
Not classified according to kind	9	7.0	1.5	6.6	0.1	8.5	76.3	693
Total		29.7	27.5	14.6	8.2	9.8	10.2	24,090

Note: Percentages for the six supplier countries sum to 100 percent (except for rounding error).

[a] Standard International Trade Classification.

[b] Scientific, medical, optical, measuring and controlling.

SOURCE: OECD, Trade Series C, obtained from Data Resources, Inc. on-line service.

Appendix Table 4B.—Supplier Export Shares to Iraq, by Commodity Class, 1982

Commodity	SITC[a]	United States	Japan	Germany	France	United Kingdom	Italy	Total value = 100 percent ($ millions)
		(percent)						
Food and live animals	0	38.8	0.4	8.0	47.2	3.8	1.7	336
Beverages and tobacco	1	0.0	0.3	5.7	7.3	65.2	21.5	126
Crude materials	2	16.8	36.2	18.3	13.8	13.0	1.8	28
Mineral fuels	3	3.6	7.2	16.3	10.9	43.2	18.8	26
Oils and fats	4	10.6	2.3	6.0	5.4	11.5	64.2	5
Chemicals	5	8.4	9.1	32.3	18.6	24.0	7.7	362
Manufactured, classified by material	6	1.9	34.2	25.8	18.9	12.3	6.8	2,083
Machinery and equipment	7	8.2	24.2	28.9	8.9	12.2	17.6	7,560
Machinery, other than electric	71	14.3	25.4	28.1	10.7	16.9	4.5	2,283
Electrical machinery	72	3.2	28.2	10.7	17.8	16.8	23.3	1,985
Telecommunications apparatus	724	2.2	32.1	7.2	30.3	28.2	0.1	526
Electrical, medical and radiological	726	47.5	11.3	19.4	4.5	13.2	4.2	16
Transport equipment	73	8.7	26.6	41.6	2.9	7.8	12.4	2,599
Road motor vehicles	732	2.6	33.3	49.0	2.5	8.0	4.6	2,027
Aircraft	734	73.8	0.0	0.0	5.4	1.7	19.1	299
Miscellaneous manufactured goods	8	2.6	25.1	22.2	15.6	23.7	10.9	613
Instruments and apparatus[b]	861	3.5	17.9	31.7	16.1	29.7	1.1	132
Not classified according to kind	9	0.7	6.0	65.5	3.1	0.7	23.9	184
Total		7.4	24.3	27.8	12.5	13.5	14.6	11,324

Note: Percentages for the six supplier countries sum to 100 percent (except for rounding error).

[a] Standard International Trade Classification.

[b] Scientific, medical, optical, measuring and controlling.

SOURCE: OECD, Trade Series C, obtained from Data Resources, Inc. on-line service.

Appendix Table 4C.—Supplier Export Shares to Egypt, by Commodity Class, 1982

Commodity	SITC[a]	United States	Japan	Germany	France	United Kingdom	Italy	Total value = 100 percent ($ millions)
		(percent)						
Food and live animals	0	65.0	1.8	5.9	24.0	2.5	0.9	881
Beverages and tobacco	1	62.0	0.0	0.4	1.2	11.5	24.9	124
Crude materials	2	58.9	2.1	12.6	11.4	11.9	3.1	74
Mineral fuels	3	20.9	0.0	1.8	12.7	5.7	59.0	222
Oils and fats	4	98.3	0.0	1.2	0.4	0.1	0.0	175
Chemicals	5	13.1	3.4	29.4	19.5	22.7	11.9	448
Manufactured, classified by material	6	22.3	20.5	19.4	19.0	9.6	9.1	770
Machinery and equipment	7	27.2	12.6	22.3	14.7	8.2	14.9	3,335
Machinery, other than electric	71	39.7	7.4	26.5	12.8	12.3	1.4	1,349
Electrical machinery	72	20.2	22.8	11.0	13.3	8.9	23.8	885
Telecommunications apparatus	724	20.6	49.8	5.5	13.6	10.4	0.2	268
Electrical, medical and radiological	726	23.7	16.8	39.2	10.5	9.3	0.6	9
Transport equipment	73	21.1	13.0	29.1	21.7	3.1	12.0	918
Road motor vehicles	732	14.1	21.5	35.9	15.5	3.5	9.4	487
Aircraft	734	39.0	0.0	0.0	49.2	3.7	8.1	218
Miscellaneous manufactured goods	8	23.0	19.0	16.0	12.9	20.2	9.0	249
Instruments and apparatus[b]	861	29.0	15.1	20.4	12.7	21.2	1.7	78
Not classified according to kind	9	7.9	2.3	15.0	0.7	44.7	29.4	75
Total		33.3	10.4	18.0	15.8	9.3	13.2	6,353

Note: Percentages for the six supplier countries sum to 100 percent (except for rounding error).

[a] Standard International Trade Classification.

[b] Scientific, medical, optical, measuring and controlling.

SOURCE: OECD, Trade Series C, obtained from Data Resources, Inc. on-line service.

Appendix Table 4D.—Supplier Export Shares to Iran, by Commodity Class, 1982

Commodity	SITC[a]	United States	Japan	Germany	France	United Kingdom	Italy	Total value = 100 percent ($ millions)
		(percent)						
Food and live animals	0	10.0	2.0	39.2	44.1	4.3	0.4	216
Beverages and tobacco	1	0.0	0.0	69.7	0.0	2.7	27.5	33
Crude materials	2	1.0	44.0	27.0	2.5	25.0	0.5	109
Mineral fuels	3	0.3	0.1	14.6	0.9	1.2	82.8	271
Oils and fats	4	22.8	1.4	65.7	7.6	1.7	0.7	10
Chemicals	5	2.3	11.9	42.5	9.2	18.2	15.9	468
Manufactured, classified by material	6	0.3	51.0	32.1	3.5	8.1	5.1	757
Machinery and equipment	7	3.6	20.0	34.6	7.3	16.7	17.8	2,069
Machinery, other than electric	71	7.6	32.6	34.2	4.5	18.5	2.6	724
Electrical machinery	72	2.6	14.6	33.6	3.5	11.3	34.4	434
Telecommunications apparatus	724	0.1	21.9	68.5	2.4	7.0	0.0	52
Electrical, medical and radiological	726	4.5	35.6	41.1	4.4	9.9	4.4	9
Transport equipment	73	1.2	15.1	41.3	13.7	21.4	7.2	754
Road motor vehicles	732	0.8	15.0	54.0	1.9	27.5	0.8	557
Aircraft	734	2.9	0.0	0.0	89.1	6.7	1.3	103
Miscellaneous manufactured goods	8	5.8	21.4	45.2	5.6	20.3	1.7	116
Instruments and apparatus[b]	861	5.7	30.9	35.5	3.8	23.0	1.1	55
Not classified according to kind	9	2.0	15.9	36.4	0.7	1.2	43.8	13
Total		3.0	23.0	34.4	8.1	13.7	17.8	4,060

Note: Percentages for the six supplier countries sum to 100 percent (except for rounding error).

[a] Standard International Trade Classification.

[b] Scientific, medical, optical, measuring and controlling.

SOURCE: OECD, Trade Series C, obtained from Data Resources, Inc. on-line service.

Appendix Table 4E.—Supplier Export Shares to Algeria, by Commodity Class, 1982

Commodity	SITC[a]	United States	Japan	Germany	France	United Kingdom	Italy	Total value = 100 percent ($ millions)
		(percent)						
Food and live animals	0	22.0	0.1	30.0	28.1	19.7	0.1	567
Beverages and tobacco	1	4.3	0.0	0.0	0.9	1.4	93.3	205
Crude materials	2	42.3	9.2	13.9	28.5	5.7	0.5	52
Mineral fuels	3	33.4	2.2	8.6	5.3	26.9	23.6	183
Oils and fats	4	56.6	0.1	19.7	23.6	0.0	0.0	29
Chemicals	5	3.5	1.3	23.1	63.1	4.6	4.3	367
Manufactured, classified by material	6	4.7	14.4	29.0	45.3	3.6	3.0	967
Machinery and equipment	7	11.3	15.4	22.8	35.8	3.7	11.0	3,164
Machinery, other than electric	71	12.3	16.0	27.3	39.0	3.4	2.1	1,272
Electrical machinery	72	6.4	18.3	13.7	28.4	4.7	28.4	554
Telecommunications apparatus	724	14.6	18.6	38.3	11.3	17.2	0.0	86
Electrical, medical and radiological	726	0.1	7.7	23.8	60.3	4.6	3.6	31
Transport equipment	73	14.1	15.5	22.5	41.1	4.3	2.6	1,169
Road motor vehicles	732	10.9	17.9	22.3	43.5	3.6	0.8	1,013
Aircraft	734	97.6	0.0	0.0	0.1	2.3	0.0	50
Miscellaneous manufactured goods	8	3.0	13.7	20.0	52.4	3.4	7.4	271
Instruments and apparatus[b]	861	1.8	12.3	27.2	51.6	5.5	1.6	88
Not classified according to kind	9	7.0	2.1	35.0	1.4	3.7	50.8	29
Total		11.3	11.6	23.2	36.6	5.9	11.4	5,834

Note: Percentages for the six supplier countries sum to 100 percent (except for rounding error).

[a] Standard International Trade Classification.

[b] Scientific, medical, optical, measuring and controlling.

SOURCE: OECD, Trade Series C, obtained from Data Resources, Inc. on-line service.

Appendix Table 4F.—Supplier Export Shares to Kuwait, by Commodity Class, 1982

Commodity	SITC[a]	United States	Japan	Germany	France	United Kingdom	Italy	Total value = 100 percent ($ millions)
		(percent)						
Food and live animals	0	23.0	6.0	18.5	25.7	26.6	0.3	129
Beverages and tobacco	1	41.8	5.3	0.5	0.9	37.5	14.0	66
Crude materials	2	79.5	2.7	3.1	3.8	10.9	0.0	11
Mineral fuels	3	16.6	2.8	6.5	10.9	10.2	53.0	40
Oils and fats	4	69.0	0.1	6.3	4.6	11.8	8.2	3
Chemicals	5	19.2	7.4	19.5	11.7	39.3	2.9	162
Manufactured, classified by material	6	10.5	63.4	8.9	5.5	10.3	1.3	962
Machinery and equipment	7	20.8	36.1	19.0	5.1	9.3	9.7	2,778
Machinery, other than electric	71	25.8	39.4	19.5	4.2	10.6	0.4	784
Electrical machinery	72	10.2	37.9	13.4	10.5	16.0	12.1	758
Telecommunications apparatus	724	10.1	74.2	6.7	1.4	7.6	0.0	134
Electrical, medical and radiological	726	25.4	3.9	26.8	0.2	31.6	12.2	7
Transport equipment	73	26.5	36.4	24.1	2.6	4.8	5.6	1,119
Road motor vehicles	732	24.1	41.3	28.6	1.3	3.6	1.1	805
Aircraft	734	68.5	0.0	0.0	6.8	1.8	22.9	131
Miscellaneous manufactured goods	8	11.7	29.1	13.1	11.7	14.0	20.5	514
Instruments and apparatus[b]	861	16.8	33.0	19.1	6.5	23.7	1.0	43
Not classified according to kind	9	5.5	0.9	20.9	0.1	6.9	65.8	277
Total		17.4	36.2	16.2	6.3	11.7	12.2	4,942

Note: Percentages for the six supplier countries sum to 100 percent (except for rounding error).

[a] Standard International Trade Classification.

[b] Scientific, medical, optical, measuring and controlling.

SOURCE: OECD, Trade Series C, obtained from Data Resources, Inc. on-line service.

CHAPTER 5

Petrochemical Technology Transfers

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CHAPTER 5

Petrochemical Technology Transfers

INTRODUCTION

Petrochemical technology transfer to the Middle East is of interest for several reasons. First, petrochemical manufacture involves complex technologies that are often difficult to master, heightening the importance of training programs for indigenous personnel. Because petrochemical products are sold in a world marketplace, efficient operation and quality control are critical. Second, petrochemical production is a very capital-intensive, feedstock-dependent industry where plants with a small number of highly trained personnel and inexpensive energy supplies can be cost competitive, even in remote locations. Several Middle Eastern countries are in this situation. With their small populations, substantial oil income that permits operation at world scale-capacity, using state-of-the-art technology and formerly wasted (flared) natural gas resources, downstream operations such as petrochemicals may be the most appropriate technology for such countries. Third, actual construction, licensing, and operation of petrochemical plants and marketing of the products is a lucrative business for foreign suppliers. Finally, the huge plants presently under construction or planned in the Middle East could cause severe dislocations in world commodity petrochemical markets once they come onstream. If more capacity is brought online in a slack world petrochemical market, this may quicken the pace of industry restructuring, particularly in Western Europe and Japan.

This chapter assesses the present status of Middle Eastern petrochemical production, perspectives of recipient and supplier countries and firms, and long-term developments. Finally, it addresses U.S. policy options, which are fairly limited.

One major theme is that, despite limited absorption of petrochemical technology by indigenous workers, Middle Eastern petrochemical facilities can be expected to operate efficiently and contribute significantly to their export revenues. Another major theme is the potential for negative effects on manufacturers in industrial countries, possibly leading to trade disputes, as these plants come onstream.

PETROCHEMICAL PRODUCTION IN THE MIDDLE EAST

Production of petrochemicals is an extremely complex industry wherein scores of international firms produce and trade many different feedstocks, intermediates, and product chemicals.[1] Central to the process is the conversion of feedstocks, such as natural gas or byproducts from the oil refining process, into basic petrochemicals such as ethylene, methanol, ammonia, and a limited range of simple derivatives such as low-density polyethylene and polyvinylchloride (PVC) (see app. 5A). Technical expertise is required in selecting appropriate feedstocks, products, and processes to produce those products; constructing, operating, and maintaining the plants; and marketing and distributing the products.

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[1] Feedstocks are used in the first step of petrochemicals production and include natural gas, natural gas liquids, and crude oil. Intermediates such as butylenes arise during the course of steps leading toward production of desired petrochemical products and are generally not used by themselves as finished chemicals. Product chemicals, such as methanol and ammonia, can be used independently or further processed.

PRESENT AND NEAR-TERM STATUS OF PETROCHEMICALS IN THE MIDDLE EAST

Several countries in the Middle East currently plan or have petrochemical construction projects underway: Saudi Arabia, Kuwait, Algeria, Qatar, Bahrain, Iran, Iraq, Abu Dhabi (UAE), Egypt, and Libya. Each country's specific needs in developing its petrochemical sector, as embodied in invitations to bid and contract negotiations, vary and are a function of the following factors: 1) technological requirements, including type of process and products sought and the planned scale of production; 2) local administrative and operational capabilities; 3) the financial resources of the purchasing country or enterprise; and 4) political and cultural considerations.

To take advantage of economies of scale, Middle Eastern petrochemical plants are planned to be very large; the number of projects is relatively few. Petrochemical plants are complex installations that are usually custom designed. Proven technology for petrochemical processes and products is widely available from suppliers in the United States, Japan, and Western Europe. Technological competition among these suppliers has centered on marginal differences in product yield, energy use, and product mix. Often the contractors must have a track record on work of a similar scale and have proven logistics capabilities. Suppliers usually have entered into either joint ventures or the construction of turnkey plants for national companies or state-owned industrial enterprises. Even more than is the case for some of the other technology sectors analyzed in this assessment (telecommunications and commercial aircraft support), no commodity trade classifications adequately capture imports of equipment for these plants.[2]

THE MIDDLE EASTERN PETROCHEMICAL INDUSTRY IN GLOBAL CONTEXT

To put the petrochemical situation in the Middle East and North Africa in perspective, tables 33 through 40 list the region's 1981 and projected future capacities for ethylene,[3] low-density polyethylene (LDPE)/linear low-density polyethylene (LLDPE), high-density polyethylene (HDPE), ethylene glycol, styrene, methanol, and ammonia. These are all "primary" or "commodity" chemicals: they are produced in large volume, by many companies, to standard specifications, and traded internationally, with price being a critical factor in trade.[4] Uses for these products in downstream operations are indicated later in table 43. Since various petrochemical projects have been announced and then postponed, the announced dates are subject to considerable change and are not included. Projects listed are expected by OTA to come onstream.[5]

As indicated in table 33, the most significant expected development in the Middle East is the rapid increase in ethylene capacity, expected to increase nearly sixfold in 1985 to 1990, with more than half of this increase reflecting the completion of Saudi Arabian projects. An additional 15 percent of new capacity could be added if Iraqi and Iranian projects are resumed. Considering that the bulk of this ethylene volume will be ethylene derivatives for export, the impact of these projects will be significant.

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[2] No Standard International Trade Classification (SITC) product analysis is thus attempted, since equipment used in petrochemical production is included under a number of classifications, including Revised SITC 7148 (gas turbines); 742 (liquid pumps); 7431 (gas pumps); 7284 (special industrial machinery; and control instruments). It is impossible to disaggregate the imports under these categories destined specifically for petrochemical projects.

[3] Olefins (e.g., ethylene, propylene, or butadiene) are considered to be primary chemicals, or building blocks which can be used to produce a range of derivative products.

[4] Chemical intermediates (sometimes referred to as "secondtier" chemicals) are produced from other chemicals. For example, the intermediate chemical polyvinyichlorid (PVC) is itself produced from ethylene and chlorine, both commodity chemicals. "Specialty chemicals," unlike commodity chemicals, are relatively low-volume, high value-added products which are often produced by one or only a few companies. They are often specifically formulated for a particular customer for uses such as water treatment chemicals, lubricating additives, special adhesives, or electronic chemicals.

[5] The cost of canceling a project is often not large if done sufficiently early. In the case of the canceled project of Dow Chemical in Saudi Arabia, approximately 1.5 years after the project was announced, the company reportedly wrote-off only $26 million; the total value of the project is $1.5 billion.

Table 33.—Middle East and North African Ethylene Capacity, 1981 (thousand metric tons per year)

Country/company	Location	1981 capacity	Feedstock	Expansions (year)
Middle East:				
Kuwait:				
PIC	Shuaiba	—	Ethane	+350 (1988-90)
Saudi Arabia:				
SABIC/Shell	Al-Jubail	—	Ethane	+650 (1985-86)
SABIC/(Dow)/Mitsubishi	Al-Jubail	—	Ethane	+500 (1986)
SABIC/Mobil	Yanbu	—	Ethane	+450 (1985)
Iraq:				
Ministry of Industry	Basra	(130)[a]	Ethane	+130 (Restart 1985-90)
Iran:				
Abadan Petrochemical	Abadan	(25)[a]	Naphtha	Closed
Iran-Japan	Bandar Khomeini	—	Naphtha	+300 (1990-95)
Turkey:				
Petkim	Yarimca	55	Naphtha	
Petkim	Aliaga	—	Naphtha	+300 (1984-85)
Qatar:				
QAPCO	Umm Said	280	Ethane	—
Other	—	130	—	+70 (1989)
North Africa:				
Algeria:				
Sonatrach	Skikda	120	Ethane	—
Libya:				
Ras Lanuf Oil & Gas Processing	Ras Lanuf	—	Naphtha	+300 (1984-85)
Total		585		3,050

[a] Capacity installed, but facility not operational as of 1984.

SOURCE: Office of Technology Assessement.

Table 34.—Middle East and North African LDPE and LLDPE Capacity, 1981 (thousand metric tons per year)

Country/company	Location	1981 capacity	Product	Expansions (year)
Middle East:				
Kuwait:				
PIC	Shuaiba	—	LLDPE	+165 (1988-90)
Saudi Arabia:				
SABIC/Exxon	Al-Jubail	—	LLDPE	+260 (1985)
SABIC/(Dow)/Mitsubishi	Al-Jubail	— —	LLDPE LDPE	+120 (1986) +130 (1986)
SABIC/Mobil	Yanbu	—	LLDPE	+200 (1985)
Iraq:				
Ministry of Industry	Basra	(60)[b]	LDPE	Restart (1985-90)
Iran:				
Iran-Japan	Bandar Khomeini	—	LDPE	+100 (1990-95)
Turkey:				
Petkim	Yarimca	24	LDPE	
Petkim	Aliaga	—	LDPE	+150 (1984-85)
Qatar:				
QAPCO	Umm Said	140	LDPE	—
Other	—	96	LDPE	—
North Africa:				
Algeria:				
Sonatrach	Skikda	48	LDPE	—
Libya:				
Ras Lanuf Oil & Gas Processing	Ras Lanuf	— —	LDPE LLDPE	+50 (1987) +80 (1987)
Egypt:[a]				
EGPC	Alexandria	—	LDPE	+90 (1990)
Total		308		1,405

[a] Based on imported ethylene.
[b] Not operational as of 1984.

SOURCE: Office of Technology Assessment.

Table 35.—Middle East and North African HDPE Capacity, 1981
(thousand metric tons per year)

Country/company	Location	1981 capacity	Expansions (year)
Middle East:			
Kuwait:			
PIC	Shuaiba	—	—
Saudi Arabia:			
SABIC/(Dow)/Mitsubishi	Al-Jubail	—	80 (1986)
SABIC/Mobil	Yanbu	—	100 (1985)
Iraq:			
Ministry of Industry	Basra	—	30 (1985-90)
Iran:			
Iran-Japan	Bandar Khomeini	—	60 (1990-95)
Turkey:			
Petkim	Yarimca	—	
Petkim	Aliaga	—	40 (1984-85)
Qatar:			
QAPCO	Umm Said	—	70 (1986-87)[a]
North Africa:			
Libya:			
LNOC	—	—	50 (Planned)
Egypt:[a]			
EGPC	Alexandria	—	40 (1990)
Total		—	470

[a] Ultimately it may be a conversion and expansion of its LDPE facility to LLDPE. An LLDPE facility could be used to produce a range of products from LLDPE to HDPE.

SOURCE: Office of Technology Assessment.

Table 36.—Middle East and North African Ethylene Glycol Capacity, 1981
(thousand metric tons per year)

Country/company	Location	1981 capacity	Expansions (year)
Middle East:			
Kuwait:			
PIC	Shuaiba	—	+135 (1988-90)
Saudi Arabia:			
SABIC/(Dow)/Mitsubishi	Al-Jubail	—	+300 (1986)
SABIC/Mobil	Yanbu	—	+200 (1985)
Turkey:			
Petkim	Aliaga	—	+68 (1984-85)
North Africa:			
Libya:			
Ras Lanuf Oil & Gas Processing	Tobruk	—	+50 (1987)
Total		—	753

SOURCE: Office of Technology Assessment.

Tables 34 through 37 indicate the types of derivative capacity expected onstream in the Middle East region during the 1980's. As shown in these tables, polyethylene—especially in the form of LDPE and LLDPE—will predominate over other forms of ethylene derivatives. Most of this material will be exported to Asia, Africa, and Europe. Similar distribution patterns are expected for other olefin-derivative exports.

Tables 38 through 40 for methanol and ammonia include export projects under development in the Middle East and North Africa. A

Table 37.—Middle East and North African Styrene Capacity, 1981
(thousand metric tons per year)

Country/company	Location	1981 capacity	Expansions (year)
Middle East:			
Kuwait:			
PIC	Shuaiba	—	+340 (1988-90)
Saudi Arabia:			
SABIC/Shell	Al-Jubail	—	+300 (1985-86)
Iran:			
Iran-Japan	Bandar Khomeini	—	+20 (1990-95)
Turkey:			
Petkim	Yarimca	20	—
North Africa:		—	—
Total		20	660

SOURCE: Office of Technology Assessment.

Table 38.—Middle East and North African Methanol Capacity, 1981 (thousand metric tons per year)

Country	Company	Location	Feedstock[a]	Capacity	Expansions (year)
Middle East:					
Egypt	Egyptian Petroleum	Alexandria	NG	10	—
Saudi Arabia	SABIC/Mitsubishi Gas Chemical	Al-Jubail	NG	—	600 (1983)
	SABIC/Celanese/Texas Eastern	Al-Jubail	NG	—	650 (1985)
Bahrain	SABIC/PIC/BANOCO	Sitra Island	NG	70	360 (1984-85)
Other			NG	60	
North Africa:					
Algeria	Almer	Arzew	NG	110	—
Libya	Libyan Methanol	Marsa El Brega	NG	330	330 (1985)
Total Middle East and North Africa				580	

[a] Natural gas.

SOURCE: Office of Technology Assessment.

significant number of the ammonia projects in this region are dedicated to domestic fertilizer consumption.

For purposes of comparison, table 41 shows petrochemical production outside the Middle East in 1982 for the same eight commodity chemicals covered in tables 33-40. Middle East production—particularly of ethylene, LDPE and LLDPE—is significant when compared with non-U.S. producers (Western Europe, Japan, Canada, Mexico). U.S. production figures dwarf those of all other countries, including those in the Middle East, reflecting the large domestic U.S. market. It should be remembered that, because a large part of Middle East output is targeted to export markets, these plants will have a large impact on world trade in these chemicals. As indicated in table 41, production declined in many cases in recent years. This foreshadows significant restructuring ahead as the large Middle Eastern plants come onstream during the next few years.

PERSPECTIVES OF RECIPIENT COUNTRIES AND FIRMS

To understand how petrochemical technology is transferred to the Middle East and the implications of this transfer, OTA assessed projects in Saudi Arabia, Kuwait, Bahrain, Qatar, and Algeria. Because Iranian, Iraqi, and Egyptian projects will have minimal im-

Table 39.—Middle Eastern Ammonia Capacity, 1981 (thousand metric tons per year)

Country/company	Location	Capacity	Feedstock[a]	Expansions (year)
Bahrain:				
Gulf Petrochemical	Sitra	—	NG	270 (1984-85)
Iran:				
Iran Fertilizer	Shiraz	28	NG	320 (1982-83)
NPC	Bandar Khomeini	540	NG	Damaged due to war
Iraq:				
Ministry of Industry	Basra	272	NG	Damaged due to war
	Um Qassr	272	NG	544 (Planned)
	Al-Kain	—	NG	41 (1984-85)
Kuwait:				
PIC	Shuaiba	330	NG	
	Shuaiba	220	NG	270 (1983-84)
Qatar:				
QAPCO	Um Said	480	NG	
Saudi Arabia:				
Safco	Damman	160	NG	
SAMAD	Al-Jubail	—	NG	270 (1983-84)
Turkey:				
IGSAS	Ismit	270	N	
	Kirklareli	—	NG	270 (1983-84)
Azot Sanayii	Kutahya	124	N	
	Silifke	—	N	270 (1983)
United Arab Emirates:				
ADNOC	Ruwais	—	NG	270 (1984)
	Ruwais	—	NG	270 (1985)
Other		80	N	270 (1985-90)
Total Middle East		3,086		

[a] Feedstocks: NG = natural gas; N = naphtha.

SOURCE: Office of Technology Assessement.

Table 40.—North African Ammonia Capacity, 1981 (thousand metric tons per year)

Country/company	Location	Capacity	Feedstock[a]	Expansions (year)
Algeria:				
Sonatrach	Arzew	—	NG	270 (1980-81)
	Arzew	—	NG	270 (1980)
	Annaba	—	NG	270 (1983-84)
	Skikda	—	NG	270 (Planned)
Egypt:				
Nasr	Helwan	49	COG	
Kima	Aswan	119	N	
El Nasr d'Engrais et Ind Chimiques	Suez	48	N	
	Talkha	98	N	325 (1980-81)
State	Abu Qir	—	NG	326 (1979-80)
Libya:				
LNOC	Marsa El Brega	270	NG	270 (1984-85)
Morocco:				
OCP	Jorf Lasfar	—	N	270 (Planned)
Nitromar	Mohammadia	—	N	90 (Planned)
Sudan:				
State	Port Sudan	—	N	50 (1983) 50 (1985)
Tunisia:				
Groupe Chimique	Gabes	—	NG	270 (1985)
Total		584		

[a] Feedstocks: NG = natural gas; COG = coke oven gas; N = naphtha.

SOURCE: Office of Technology Assessement.

Table 41.—Petrochemical Production Outside of the Middle East Region, 1982
(thousand metric tons produced/average annual growth, 1981-82, %)

	United States	France	Italy	United Kingdom	West Germany	Japan	Canada	Mexico
Ethylene	11218.2/−16.2	1868.2/1.0	909.1/0.0	1081.8/−13.0	2636.4/−9.0	3590.0/−2.0	1010.0/−24.0	400.0/5.0
Low-density polyethylene	3409.1/−2.0	881.8/0.0	509.1/−5.0	418.2/−8.0	1122.7/−6.0	1670.0/0.0	570.0/−10.0	90.0/2.0
Linear low-density polyethylene								
High-density polyethylene	2240.9/5.0							80.0/0.0
Ethylene glycol	1954.6/3.7				181.8/−17.0	390.0/−6.0		
Styrene	2695.5/−11.3	309.1/18	309.1/6.0	136.4/−6.0		1090.0/−1.0		30.0/12.0
Methanol	3300.0/−15.5	340.9/−2.0			709.1/2.0	630.0/−15.0		190.0/6.0
Ammonia	14081.8/−18.6	1900.0/−16.0	1259.1/−15.0		1568.2/−20.0		2510.0/−5.0	2470.0/13.0

SOURCE: "Facts and Figures for the Chemical Industry," *Chemical and Engineering News*, June 13, 1983, pp. 26ff.

pacts on world petrochemical markets, they are only briefly reviewed.

GOALS AND OBJECTIVES

While their priorities may be different, the goals and objectives of the Middle Eastern countries are similar. Simply stated, their objective in petrochemical development is to move away from overdependence on oil toward a profitable manufacturing area that involves use of natural resources (natural gas) that have been wasted (flared) in the past. The development, via technology transfer, of a petrochemical industry is also a matter of national pride. They expect their petrochemical development efforts to result in:

- Revenues or profits to support future economic growth.
- Human resource development—A dynamic industrial environment that would create employment, stimulate training with clear objectives, support industries giving an outlet to the local entrepreneurs, and foster a group of technocrats to support future national growth.
- The basis for future downstream industries.

The goals and objectives of these countries differ little from those typical of developing countries. Some of the more fundamental questions have been how to finance technology without incurring inordinate amounts of debt, where to gain access to low-cost raw materials, the degree of capital intensity or sophistication of the technology, the availability of trained manpower, structuring relationships with multinational corporations, and the implications of modern or Western technology on local culture.

The Middle East, with its unique combination of purchasing power and comparatively low level of industrialization, provides a challenging area for petrochemical development. Raw materials for petrochemicals are plentiful in this region and, in the case of the Gulf States, can be considered "free" because they are derived in association with crude oil production. This utilization of abundant natural resources helps mitigate the increased costs of building and operating petrochemical plants in the Middle East. Moreover, the initial capital for petrochemical projects and the hiring and training of local and foreign manpower can be financed through use of energy-derived funds and anticipated future project returns for collateral. In this environment debt, a typical constraint on many less developed countries (LDCs), has not been as important a consideration. This has made it possible to acquire the best technology available.

Middle Eastern countries have faced potential problems in a number of ways. By requiring competitive bids on all aspects of a project, potential overpayment is reduced, and through joint venture and other arrangements with foreign firms, marketing of products is planned. Cultural values are protected by citizenship restrictions and by limiting the incentives for foreign workers to go beyond their own enclaves or work camps. While a potential brain drain is an issue in these countries, professional opportunities and financial well-being should preclude a significant exodus of the educated in the more financially secure Gulf States.

PETROCHEMICAL PROJECTS

Petrochemical projects in the Middle East have been promoted by governments acting through oil ministries, state oil companies, or specialized agencies and government-controlled companies. Because local abilities of private or governmental entities to evaluate, design, engineer, construct, and operate the plants are generally inadequate to carry out these tasks independently, Middle Eastern countries have attempted to improve indigenous capabilities in these areas through participation with other countries in petrochemical projects. They also recognize a need for some level of foreign assistance from the beginning of a project through plant operation, a period generally spanning several years. Thus, through arrangements with joint venture partners, licensors, and contractors these countries expect to expedite their development process via the absorption of state-of-the-art technologies, the development of managerial, marketing, and organizational skills, as well as import substitution and local and international market development. International marketing abilities are important because, in order to achieve the level of economic scale prevalent internationally, a major portion of the output from these petrochemical projects must be exported. Since local demand will only account for approximately 10 percent of Saudi Arabia's eventual petrochemical production, the Saudi Arabian Basic Industries Corp. (SABIC) actively sought joint venture partners—Shell, Exxon, Mobil, Dow Chemical, Celanese/Texas Eastern, Mitsubishi Gas Chemical, and Taiwan Fertilizer—capable of marketing any surplus beyond the joint venture's own needs.

The development of large petrochemical projects and related infrastructure provides the opportunity for local entrepreneurs to develop supportive industries while enhancing business skills and judgment. The modernization process entailed in these projects will create a more technical and highly educated population. Hence, even trainees in petrochemical projects who leave that industry will take with them special skills and analytical tools that they and their local society might not otherwise have. These skills can be as simple as welding or as sophisticated as the management of large productive assets.

On the other hand, there are some potential disadvantages to host societies participating with foreign multinational corporations in these petrochemical projects. These perceived problems include excessive foreign profits. Multinational corporations are believed to sometimes skew their costs to the disadvantage of the host countries, drawing inordinately high returns back to their parent company while reinvesting very little, if any, funds in the host country for future development. Another type of problem involves inappropriate and inadequate training programs. All of SABIC's projects will train a large number of people, approximately 7,000 to 10,000 by 1985-86. However, this is a relatively small number in light of Saudi Arabia's total manpower development requirements. Furthermore, large capital-intensive projects do very little for the large number of underemployed in Algeria. There is also concern that research and development (R&D) efforts will never be based in the Middle East, and as a consequence, that true technology transfer will never occur. Others fear that indigenous business development will be preempted by these projects. Subsidizing wholly or even partially foreign-owned facilities, in their view, may prevent the development of similar facilities by local business and result in continuing dependence on foreign corporations. Finally, even those who do not believe that multinational corporations are necessarily exploitive still worry about potential corruption of cultural and religious value systems in their countries.

PROJECT PROFILES

The major petrochemical projects now under way in the Middle East include three large projects in Saudi Arabia (the Mobil/Saudi joint venture at Yanbu producing polyethylene and ethylene glycol; the Exxon/Saudi joint venture at Al-Jubail, producing polyethylene; and the Mitsubishi/Saudi joint venture at Al-Jubail, producing methanol). Other major projects are in Kuwait (PIC project, producing polyethylene, ethylene glycol, and styrene which is apparently on hold), in Algeria (a Sonatrach project, producing ammonia; another Sonatrach project producing liquefied natural gas—LNG), in Qatar (the QAPCO/CdF Chimie joint venture, producing polyethylene), and Bahrain (the PIC/SABIC/BANOCO joint venture, producing methanol and ammonia).* In Iran and Iraq, war has postponed petrochemical development, while in Egypt there is a well-established fertilizer industry but little likelihood that that country will become a major petrochemical producer. Summaries for each of the major eight projects are given in appendix 5B.

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*Petroleum Industries Co. (PIC), Société Nationale de Transport et de Commercialisation des Hydrocarbures (Sonatrach), Qatar Petroleum Co. (QAPCO), Bahrain National Oil Co. (BANOCO).

Saudi Arabia

Saudi Arabia is the model case of a well-financed developing country seeking to develop a modern petrochemical industry through joint ventures with foreign companies. From the foreign partner perspective, profits, crude oil, and prospects for new business have all been important incentives for participation.

Saudi Arabia has undertaken an aggressive program to establish itself as a significant world petrochemical center, although this is not immediately apparent when comparing Saudi capacity for various chemicals to world capacity. It becomes clearer in terms of the Saudi percentage of total world trade. For example, in the late 1980's, Saudi Arabia is expected to have an estimated 4 to 5 percent of world LDPE and LLDPE capacity; however, it is expected to control approximately 20 percent of world trade in this product. (Kuwait and Qatar combined could represent an additional 10 percent.)

The Saudi program includes five olefins and derivatives projects, two methanol projects, and two ammonia projects. The size and type of each of the olefins projects are shown in table 42. All of these projects are scheduled for completion in the mid-1980's and, if successful, can be expected to be followed by a second generation of projects in the 1990's. However, some of these projects may be delayed. For example, the Arabian Petrochemical Co. project recently lost Dow Chemical as a participant. While SABIC has stated that it would assume responsibility for the Dow olefins complex,[6] some delay in startup can be assumed. Moreover, the quantity of ethylene to be produced and the outlook for the LLDPE that Dow was to produce are still in question.

Most of the projects now being developed were conceived in the period 1972-74 when Petromin (the National Oil Co.) invited proposals from foreign companies. The United States, Japan, and European countries responded. However, changes in the underlying crude oil situation led some companies to pursue these negotiations less vigorously, and many of the projects, including all of European origin, were dropped. Others were deferred, then revived again in 1977-78. Today, these projects are under the jurisdiction of the Ministry of Industry and Electricity.

The so-called first-stage petrochemical projects in Saudi Arabia are 50/50 joint ventures between SABIC and foreign companies or consortia. SABIC is a limited company, established in 1976 for this specific purpose. It is responsible to the Ministry of Industry. All of its shares are held by the Saudi Government, but the Articles of Association specify that within 5 years of its establishment, a majority of the shares would be offered to the Saudi public, with the government maintaining a minority interest. This is now beginning to take place; 10 percent of the SABIC shares were recently allocated for public subscription to Gulf Corporation Council citizens.[7]

A driving force behind the establishment of these projects was the desire to utilize the large quantities of associated gas being flared at the wellhead. ARAMCO[8] was instructed to prepare and implement a gas-gathering and extraction project. The gas-gathering scheme was originally estimated at $7 billion, but estimates rose to over $17 billion before implementation. This project is expected to be completed at a lower cost of between $10 billion and $12 billion, owing to a combination of scope modification, competitive bidding on all procurement items, the impact of the world recession on prices, and careful project management. The project is now virtually complete, and liquefied petroleum gas (LPG) has been exported for some time. Ethane and methane

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[6] Toby Odone, "Petrochemicals—Dynamo or Drain?," *Middle East Economic Digest*, vol. 27, No. 42, Oct. 21-27, 1983, pp. 12-19. The downstream aspect of the project has fallen to the Mitsubishi-led consortium participating in cooperation with Eastern Petrochemical Co. in what is often referred to as the SHARQ project.

[7] Saudi Press Agency—Major News Events, Sept. 26, 1983.

[8] ARAMCO (Arabian American Oil Co.) began with a concession agreement between Saudi Arabia and Standard Oil Co. of California (Socal) in July 1933. Texaco, Exxon, and the Mobil Oil Co. were subsequently added to ARAMCO to gain investment capital and marketing outlets. The Saudi Government had a 25 percent ownership in ARAMCO in 1972, 60 percent in 1974, and now has complete ownership.

Table 42.—SABIC's Petrochemical and Fertilizer Projects

Projects	Location	Foreign partner	Estimated Cost	Percent completed by 12/31/83	Feedstock	Products	Capacity (tonnes/yr)
Saudi Petrochemical Co.	Al-Jubail	Shell	$3.0 billion	78%	Ethane	Ethylene	656
					Salt benzene	Ethylene dichloride	454
						Styrene	295
						Crude industrial ethanol	281
						Caustic soda	377
Saudi Yanbu Petrochemical Co.	Yanbu	Mobil	$2.0 billion	78	Ethane	Ethylene	455
						Linear low-density polyethylene	205
						High-density polyethylene	90
						Ethylene glycol	220
Al-Jubail Petrochemical Co.	Al-Jubail	Exxon	$1.3 billion	85	Ethylene	Linear low-density polyethylene	260
Saudi Methanol Co.	Al-Jubail	Mitsubishi	$500 million	100	Methane	Chemical grade methanol	600
National Methanol Co.	Al-Jubail	Celanese/ Texas Eastern	$500 million	86	Methane	Chemical grade methanol	650
Arabian Petrochemical Co.	Al-Jubail	Formerly Dow	$1.5 billion	14	Ethane	Ethylene	500
						Linear low-density polyethylene	120
						High-density polyethylene	60
Eastern Petrochemical Co.	Al-Jubail	Mitsubishi	$1.5 billion	27	Ethylene	Linear low-density polyethylene	130
						Ethylene glycol	300
Al-Jubail Fertilizer Co.	Al-Jubail	Taiwan Fertilizer	$350 million	100	Methane	Urea	500

NOTE: All of these plants are expected to be completed by 1985.

SOURCE: Carla Rapoport, "All Eyes on the Petrochemicals Launch," *Financial Times*, Apr. 24, 1984, p. 5.

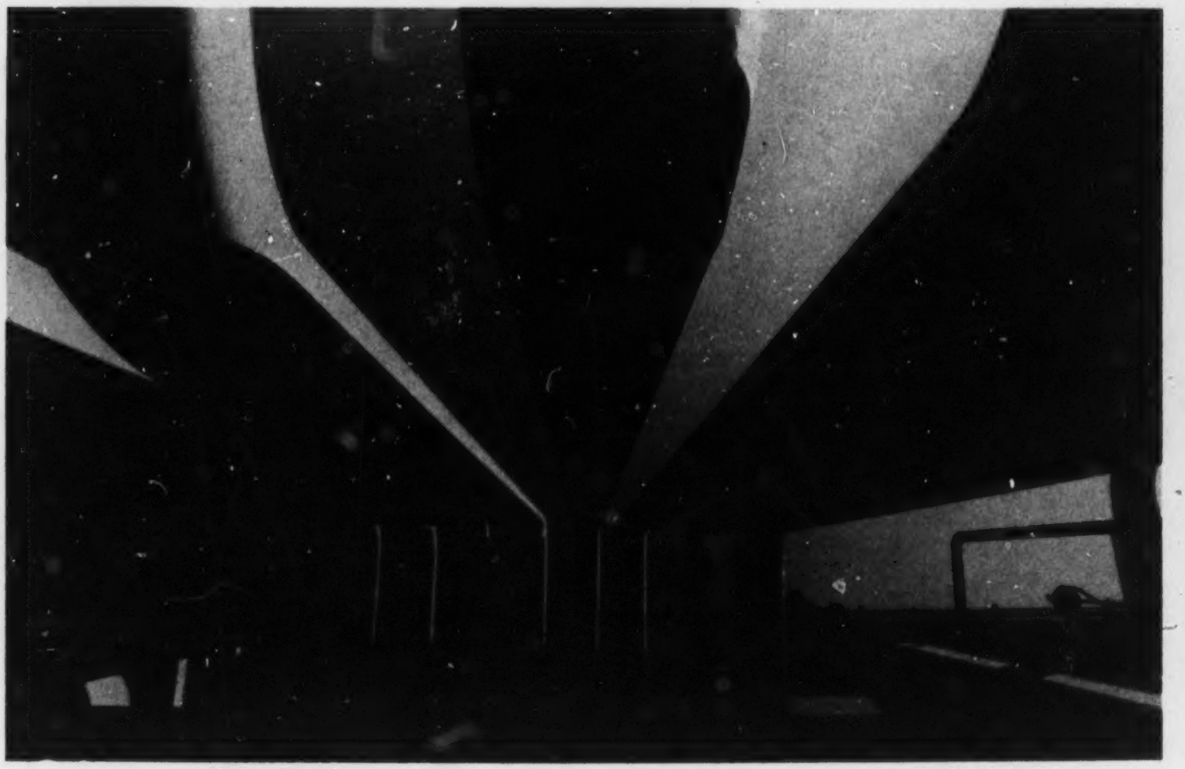

Photo credit: Aramco World Magazine

Part of Saudi Arabia's immense coast-to-coast network of plants and pipes for collecting, treating, and distributing oil-associated gases which were previously flared

are available for petrochemical and energy uses.

As part of the Saudi Arabian master plan for industrialization, two large manufacturing cities were established: Al-Jubail, located on the Persian Gulf, and Yanbu, located on the Red Sea. Plans for each include a petrochemical center, refinery, and other petroleum-related industries. The overall plan for development comprises: 1) a gas-gathering system; 2) petrochemical complexes at Al-Jubail and Yanbu; 3) methanol, ammonia and urea plants; 4) a steel mill; and 5) an infrastructure program that includes new port facilities, roads, airports, schools, universities, hospitals, housing, power generation, and desalinization facilities. Responsibility for the establishment and development of these sites was vested in a Royal Commission for Al-Jubail and Yanbu. Many U.S. contractors are involved in this development program, with Bechtel having overall management responsibility for the Al-Jubail Industrial City. It is also the primary contractor for the Yanpet Petrochemical Project. Fluor is the contractor for the gas-gathering pipeline network and petrochemical projects in Al-Jubail. Parsons manages the Yanbu Industrial City. In addition, large numbers of subcontracts have been let to both U.S. and other foreign firms for various phases of the projects.

Goals and Objectives.—The impetus behind the Saudi petrochemical program involves a desire to diversify the economy, national pride, a determination to avoid wasting natural gas and gain value-added from downstream development, and human resources development. Balance of payments considerations also underlie petrochemical development because Saudi Arabia's main resource (crude oil) is being depleted and it has few renewable resources, and because Saudi Arabia depends on imports not only for most manufactured goods but also for a large proportion of its food supplies. Consumer spending is increasing rapidly as prosperity spreads across a larger proportion of the population. In 1978, current expenditures began to exceed oil revenues, and budgets had to be cut back. The 1979 oil price increases temporarily transformed the situation, but concerns were once again raised by the decline in crude prices in the early 1980's.

Project Organization and Structure.—Although differing in some details, the projects in Saudi Arabia have been developed and are being implemented according to what is essentially a standardized scheme similar to that used by most other countries in the region. The main features of project organization and structure are detailed below:

1. Preliminary studies to establish the feasibility of the project (known as prefeasibility studies) are carried out, financed by aspirant joint venture partners.
2. Following acceptance of prefeasibility study findings by SABIC and the potential partner, an interim agreement is negotiated, covering:
    - terms for a jointly financed, full-scale feasibility study, to include sufficient engineering to establish reliable capital and operating cost estimates;
    - establishment of a joint team to carry out this feasibility study; and
    - training of key personnel.
3. Detailed agreements for feedstock supply, finance, training, marketing, licensing, technical, and management assistance are negotiated. Also negotiated are the basic principles for the agreements that define the terms under which the project will be implemented.
4. On completion and acceptance of the feasibility study, the joint venture agreement is signed authorizing the establishment of a joint company to implement the project and operate the plant. The detailed agreements referred to above form appendixes to the joint venture agreement.
5. The joint company is formed, and the project team that has supervised the feasibility study is transferred to the new company.
6. Technology is selected, and engineering and construction agreements are negotiated with contractors.
7. Recruitment of personnel commences, and full-scale training programs are implemented.

The projects in Saudi Arabia were conceived as joint ventures in which the partners make equal contributions to, and derive equal benefits from, the projects. Thus, Saudi Arabia contributes feedstock (at well below world prices),[9] financing, and a developed site with services and utilities. The foreign partners contribute technology, management, markets or marketing skills, and training of Saudi Arabian nationals.

The projects are expected to meet profitability criteria on the part of joint venture partners. The original Saudi proposal supposedly entitled a joint venture partner, from the time of signing the agreement, to lift 1,000 barrels per day (b/d) of crude oil for every $1 million invested in the joint venture. It is believed that this ratio has been changed to approximately 500 b/d of crude oil per $1 million investment. Under present world market circumstances, the value of this crude oil entitlement (to be lifted at posted prices) may be questionable. However, in more normal times, even a 2 percent net profit in handling and processing the crude would be equivalent to a 12 percent return on equity invested in the petrochemical project, and therefore, would be comparable to dividends expected from the joint venture.

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[9] The Saudi Government is reportedly charging the new petrochemical producers 50¢/million Btu for their feedstock. This compares with $4.50 to $5.00/million Btu in Western Europe, and a U.S. average of $3.30 to $3.50. While some call this a subsidy, U.S. firms involved call it a natural resource of the host country (not a subsidy). See Carla Rapoport, "All Eyes on the Petrochemicals Launch," *Financial Times*, Apr. 24, 1984, p. 5 of Special Report on Saudi Arabia.

Technology Transfer.—In the case of the SABIC/Mitsubishi Gas Chemical methanol project (now Saudi Methanol Co.), the technology (developed by Mitsubishi Gas Chemical) to be used and the engineering contractor (Mitsubishi Heavy Engineering) were specified in the interim agreement. In this case, technology transfer could be regarded as embodied in the package supplied by Japanese companies. There was, therefore, no competitive element in the selection of processes, licensors, or contractors. Chem Systems, an outside U.S. consultant, was called in to assist SABIC in evaluating the Japanese package.

In all other cases, SABIC has insisted that technology selection and engineering be on a fully competitive basis. This implies that even when the foreign partner has technology of its own for the proposed operations, it must be assessed by the joint project team against other competitive technologies. Similarly, although the foreign partner's advice is sought regarding the selection of contractors, contractors are selected on a competitive basis—by the joint project team for preliminary engineering and by the joint venture company for full engineering and construction. Thus, no firm link exists between basic technology transfer and the identity (or nationality) of the foreign partner.

Contractor Agreements.—All agreements with licensors and contractors are subject to competitive bids that allow a reasonable profit and hence incentive for the contracting party to participate in the project yet not take undo advantage of the situation.

The provision of technical and management know-how by the foreign partner is covered by a **service agreement**. This includes both project implementation and subsequent operation. The foreign partner is expected to be able to provide this know-how even though the basic technology may be obtained from another source.

The licensing of the basic technology is covered by separate **license agreements** between the joint venture company and the licensors. Such agreements normally cover startup assistance and (in some cases) continuing technology transfer relating to the specific process or products. Royalties are paid by the joint venture company or the licensors, as specified in these agreements. In the case of LLDPE, Union Carbide Corp. licensed its process to SABIC rather than to the individual joint venture companies producing LLDPE.

In all cases, the foreign partner assumes some responsibility through **marketing agreements** for disposal of products from the joint venture company. In most instances, this takes the form of a commitment to market on behalf of the company a specified minimum quantity of products, normally representing a high proportion of the output of the plant. This is accomplished through the foreign partner's international distribution network. There is also provision for disposal by the partner of any additional quantity on a best-endeavors basis.

These commitments imply that where the foreign partner has capacity to produce the products in question elsewhere in the world, it will, if necessary, be prepared to consider the cutback of production from this capacity in order to meet its commitment to the Saudi joint venture. This situation could, in times of recession, be a serious problem for the foreign partner and a penalty for the non-Saudi countries in which the partner operates. This type of problem exists whenever a company decides to locate a production facility at a foreign location—especially when payouts on new facilities are compared to those on old facilities. Escape clauses that allow reduced production when market conditions so dictate are reported to be included in Saudi Arabian project agreements. Continuing concerns regarding crude oil security may provide an added incentive to maximize production from Saudi sites.

When the foreign partner has its own requirement for the products of the company, it may be covered by a separate **offtake agreement**. Such a commitment to take products may be substituted, in whole or in part, for a quantitative commitment under marketing agreements.

Financing.—The financial provisions for Saudi joint ventures apply to all projects, though there may be minor variations. They are as follows:

1. all projects are financed with 30 percent equity, shared equally by the two partners, a 60 percent loan from the Saudi Public Investment Fund (PIF), and a 10 percent loan from commercial banks, Saudi or foreign;
2. financing covers initial fixed capital investment, interest during construction, capitalization of all expenditures under the interim agreement, initial working capital, and preoperating expenses;
3. PIF loan and equity are in strict 2:1 proportions, with a commercial loan to cover the final 10 percent of the capital requirements;
4. typical terms for commercial loans are for 5 years, with repayment in 10 equal installments, beginning at the time of startup. The PIF loan is for 20 years, with repayment in 22 equal installments commencing in the fifth year after startup;
5. the interest rates on commercial loans are negotiated with banks, the PIF loan is given at 3 to 6 percent of the outstanding sum, the actual rate is dependent on the project's return on equity;
6. dividend payments beyond a partner's share of net income after tax are subject to agreed on (debt) prepayment terms and conditions;
7. any excess of cash income over net income is to be used, after meeting other cash requirements, for prepayment of PIF loan; and
8. prepayment terms are set.

Manpower and Socioeconomic Considerations.—The objective behind the training programs is not to employ large numbers of people as much as to develop a class of technically competent individuals. Hence large, efficient, capital-intensive petrochemical projects are perfectly suited for Saudi Arabia and meet the country's training and economic development goals. Universities are being built and professors are being hired to teach engineering and science. King Fahd recently opened (coinciding with the 50th anniversary of ARAMCO) the new Petroleum Exploration and Engineering Center in Dhahran, which is considered the most modern center for oil technology in the Middle East.[10]

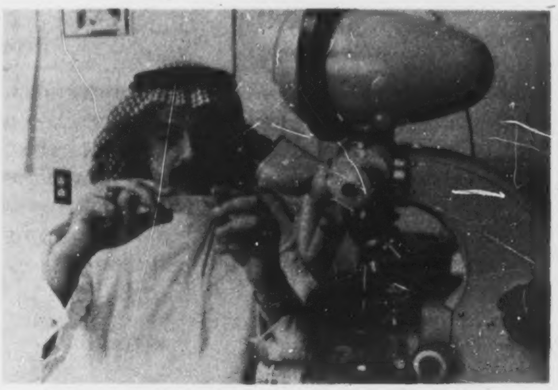

Photo credit: Aramco World Magazine

A Saudi geologist uses a petrographic microscope at the Petroleum Exploration and Engineering Center in Dhahran

The true test of domestic economic development will be the Saudis' capability to develop and manage their own projects when the second generation of petrochemical projects are undertaken in the 1990's. Another sign of development will be the ability to hold market position through expansions in capacity.

The issue of having development hinge on a large cadre of foreign laborers (and to a lesser extent managers), as is the case in the Saudi Arabian fertilizer complex and refinery, does not seem to worry many Saudis: the Saudi Arabian population is small, with an indigenous element variously estimated in the range of 4 million to 7 million and an immigrant portion exceeding 1 million. The success of the Saudi national development program over the long term, however, will depend on the ability of the indigenous population to absorb and effectively use the technology they have purchased, a process expected to bear fruit in the 1990's. Nevertheless, Saudi Arabia's goal of preserving Islamic traditions[11] must be carried out in the context of a large foreign work force.

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[10] "New Oil Center Opened," *Saudi Report*, April-May 1983.

The potential problem of foreign corporations preempting the growth of home-grown industry is being dealt with in a number of ways. First, SABIC may be made a completely publicly held corporation. In addition, incentives are being provided to domestic companies to go into downstream product development. Saudi Arabia's ability to influence the price of products their projects produce and their joint venture partners' expected desire to assist in downstream development should allow local industry to develop and prosper.

Kuwait

The Kuwaiti petrochemical project is the responsibility of Petrochemical Industries Co. (PIC), whose main business (started in the 1960's) is the production of ammonia and urea. PIC is a subsidiary of the state-owned Kuwait Petroleum Corp. (KPC), which is responsible for hydrocarbon exploration and development worldwide. The investment strategy of KPC distinguishes it from other petrochemical firms in the Middle East. Kuwait also has major investments in the United States, perhaps the most well-known being the Santa Fe International Corp. which is the corporate parent of C. F. Braun Engineering. Kuwait participates in projects in Bahrain, oil and gas exploration in Morocco and Tunisia, and a Volkswagen manufacturing facility in Brazil. Its most recent investments in Europe are a 25-percent share of Hoechst Chemical and the purchase of both Gulf Oil's refinery and gasoline station network in Western Europe. To support its hydrocarbon-related activities, the Kuwaiti Government is melding KPC into what is quickly becoming a fully integrated, multinational oil company with production, refinery, and marketing capabilities as well as chemical and petrochemical operations.

Goals and Objectives.—The basic rationale for a Kuwaiti petrochemical project differs little from the Saudi Arabian example. Reasons include national pride, diversification away from dependence solely on future crude oil production, availability of ethane from associated and nonassociated gas, and revenues from crude sales to finance the project. In addition, Kuwait has large earnings from foreign investments and a relatively small indigenous population (1.4 million), which matches well with the capital intensiveness of petrochemical production. Kuwait has made a great drive to expand its portfolio of investments away from oil, particularly if sufficient added value exists in downstream investments. Thus, it is developing its position as a major international investor equal in strength to its position as an oil producer. In fact, foreign investment capitalized from oil income reserves recently surpassed revenues from oil income.

One fundamental difference between the Kuwaiti and Saudi Arabian approaches is that the former stresses outright equity participation in foreign downstream operations, while the latter focus on joint ventures in Saudi Arabia with foreign partners who have established expertise in petrochemical production. Kuwait, for example, acquired 3,000 gasoline stations and a number of refineries and other facilities located throughout Western Europe, purchased from Gulf Oil (U.S.).[12]

Another fundamental difference between the situations of Saudi Arabia and Kuwait is the absence of large quantities of flared gas in Kuwait. As a consequence, if Kuwait proceeds with its project, it will have to address two major issues: 1) does the return on the petrochemical project meet the standards set for their portfolio of investments? and 2) can the requisite return be realized if their natural gas is priced at a value equal to that of heavy fuel oil?

It can be argued that with the absence of large quantities of excess gas, heavy fuel oil would have to be substituted for the gas currently being used for utilities and industry.

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[11] Mohammad Ali Hafiz, *Journal of Contemporary Business*, vol. 9, No. 3, 1981.

[12] "Downstream Moves Complete KPC Jigsaw," *Middle East Economic Digest*, Special Report on Kuwait, May 1984, p. 10. See also Louis Turner, "Planning an Assault on World Markets," *Middle East Economic Digest*, Aug. 12, 1983, p. 42.

Hence, this opportunity cost should set the price for ethane and the gas currently being used in utilities and for ammonia production. However, such gas is presently priced in a fashion similar to that of Saudi Arabian gas.

Project Organization and Structure.—Preliminary studies, feasibility studies, and marketing studies have proceeded in a fashion similar to that of the Saudi projects. Hoechst of West Germany is the only likely joint venture partner. Kuwait's leaders hope that the project will bring a good return on investment. Kuwait would also have the security of having its asset (the PIC complex) on its own soil. In addition, the project would add to the industrial base of the country. If a joint venture approach is not pursued, Kuwait is likely to structure a marketing agreement with a major marketer or consumer of petrochemicals, such as its current agreement with Hoechst.[13]

Initially, the intent was to have foreign joint venture partners. BASF (West Germany) was associated with the ethylene project and W. R. Grace (U.S.) with aromatics production. After a series of studies, completed by 1977, the petrochemical project was effectively shelved. Meanwhile, the new gas-processing project began operating in the late 1970's. Feedstock was thus directly available, and after the oil price rises of 1979-80, the petrochemical proj-

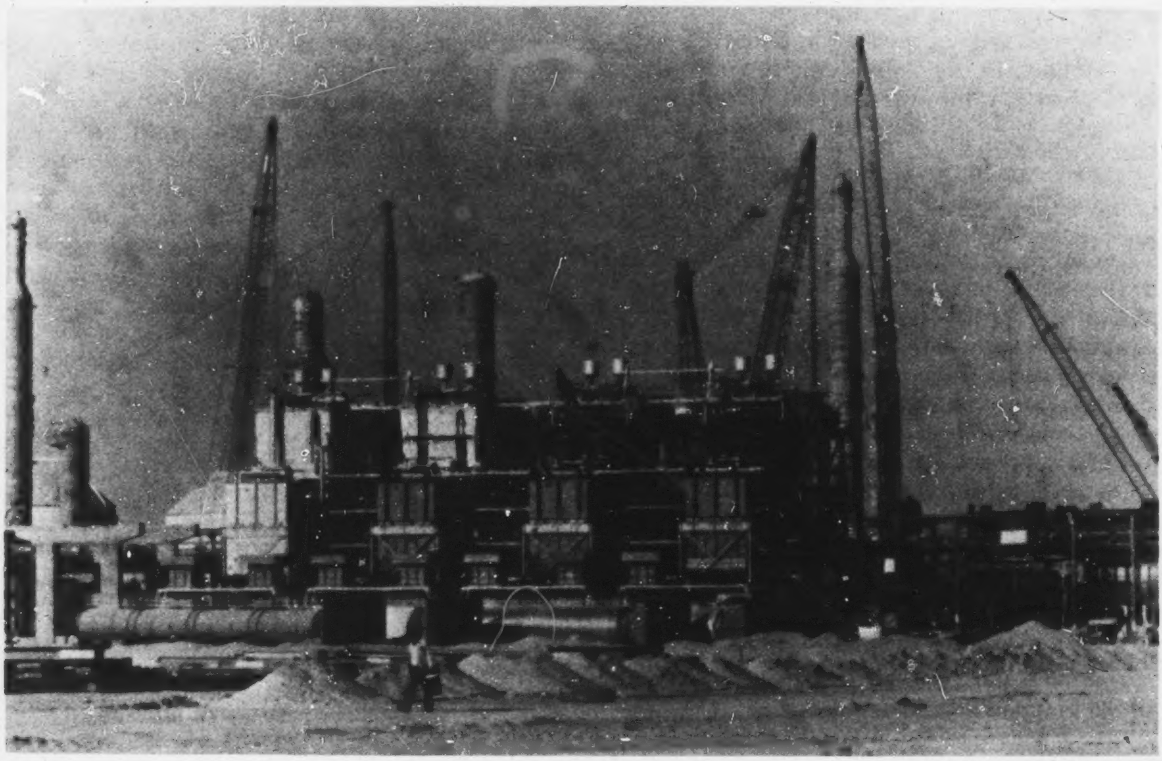

Photo credit: Bechtel Group, Inc.

Gas gathering and processing plant in Kuwait ect was revived. Preliminary engineering work was entrusted to C. F. Braun. The plan was for KPC and PIC to agree on the viability of a project and then proceed in concert with "unrelated" foreign partners.

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[13] Hoechst of West Germany signed two letters of intent formalizing plans both to buy ammonia and to market chemical fertilizers from the Kuwait Petrochemical Industries Co., a subsidiary of KPC. See Carla Rapoport, "Hoechst Signs Deal With Kuwait Petrochemicals," *Financial Times*, Feb. 2, 1984, p. 5. See also Jumada al-Thani, "Hoechst Plans to Service Kuwait and Saudi Arabia," *Arabia*, March 1984, p. 59.

PIC commissioned development of a marketing plan for a set of proposed products. This study was completed in the fall of 1982, with indications that the project was proceeding. In 1983, however, there were reports that the project had been shelved once again, but due mainly to marketing considerations and difficulties in anticipating feedstock supplies as a result of vagaries in the oil market. The status of Kuwait's petrochemical project thus remains uncertain.[14]

Technology Transfer.—The project is thus still in the planning stage. C. F. Braun would eventually be its likely transferring agent if the project is implemented. Since it is likely that Kuwait will not have a joint venture partner, and it owns the engineering firm, the only source of truly foreign technology will be licensors.

Socioeconomic Considerations.—Along with its decisions to conserve its oil, to export increasing quantities of refined products rather than crude oil (to derive added value), and to limit heavy industrialization in favor of supporting the service sector (i.e., banking and reexports), Kuwait will support petrochemical development as long as it provides a good return compared to that of other investments in its portfolio. Within this context of a general development strategy focusing on service sector expansion, petrochemical development, with its spinoff effect on employment, education, and support businesses, is far less important to Kuwait than to Saudi Arabia.

While a fundamental difference between Kuwait and Saudi Arabia is Kuwait's propensity to invest in foreign ventures, Kuwait also differs in its conduct of domestic projects. The Kuwaitis are involved in fewer projects, and do not favor joint venture arrangements. This reflects their desire to realize maximum benefit from their investments. The Kuwaitis, like the Saudis, are not averse to employing noncitizen Arab (e.g., Palestinian) and Western workers to run their projects as long as this employment practice does not detract from their project expectations.

Algeria

Algeria is a country distinctly different from the Gulf countries previously analyzed. Perhaps more concerned to limit participation by foreigners, Algerians nevertheless find themselves in a position similar to that of many Gulf States in their need for foreign technology to effectively use hydrocarbon resources. Unfortunately, Algeria is not as rich in oil as Saudi Arabia, and therefore does not have the financial resources to purchase the technology, infrastructure, education, and industrial base at the same rate or magnitude as Saudi Arabia. Nevertheless, hydrocarbons represent over 25 percent of Algeria's gross domestic product, approximately 50 percent of government revenues, and more than 95 percent of export earnings. Crude oil and LNG exports are the major factors in export earnings.

Algeria is the first OPEC nation to attempt building a modern petrochemical industry using natural gas and natural gas liquids. The impetus behind its efforts reflects its determination to industrialize and reach self-sufficiency in those commodity areas where it has an advantageous position in raw materials. Sonatrach, the state energy company, is responsible for all petrochemical projects. It has been involved with one olefin and derivatives complex, three ammonia projects, and three LNG projects.

A massive program of capital investment in the late 1960's and 1970's was largely directed at converting Algeria's abundant reserves of natural gas into export products. Thus, LNG, LPG, and condensate[15] recovery plants were authorized as well as ammonia and petrochemicals (from ethane). During this period, Algeria's principal income was from a modest volume of crude oil exports which was insufficient to support the investment program.

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[14] The project may have been effectively canceled in November 1982. There was still a certain amount of confusion with PIC spokesmen insisting that the project was still going ahead, although KPC officials said it was dead in its current form. Some combination of worries about end markets, competition from the new Saudi ventures, and perhaps the availability of sufficient gas feedstocks within Kuwait meant that the advantages of the project became less and less convincing; Wharton Middle East Economic Service, *The Petrochemical Industry in the Middle East: Current Status, Uncertainties, Global Impact*, Special Report #2, April 1983, pp. 27-28.

In recent years, the rate of capital expenditure slackened dramatically as planners faced construction and then operating problems.[16] Many of the ambitious plans of the 1970's were shelved, including a refinery, an aromatics project, and a second ethylene project.

Construction of the first ammonia project in Algeria was initiated by Chemico (U.S.), using its own technology. The project was later taken over by Technip and Creusôt-Loire, however, employing the same Chemico technology. Completed in the early 1970's, the project included a downstream urea facility. The ammonia plant never operated satisfactorily, despite repeated modifications by the contractors, and was finally shut down in 1980 for a major revamping, which was carried out by Technip/Creusôt-Loire.

In the meantime, two new ammonia project contracts, one at Arzew and one at Annaba/Skikda, were awarded in 1974-75 to a group of licensors and contractors. The Arzew project was commissioned in early 1981. The U.S. firm Kellogg, which has a technical assistance contract with Sonatrach to operate the ammonia plant, has assigned approximately 50 men to Arzew. With Kellogg's involvement, this plant is thought to run well and is approaching design capability. However, actual production from the facility has been limited. The Annaba plant has not begun operations.

The Algerians have had similar operating problems with LNG facilities. The first major LNG facility was engineered by Chemico but was completed by Bechtel. The project took over 4 years to complete. Difficulties relating to pricing policy resulted in its having only limited use. The second major LNG facility was constructed by Kellogg, also in Arzew. This facility also took a comparatively long time by Western standards to build—reportedly because of the lower level of technical skills in Algeria. For a time the facility was operated by El Paso Gas, but that arrangement failed when the issue of pricing to the United States could not be resolved. Kellogg is now responsible for the operation of both complexes under a management and training service agreement. A third LNG complex in Arzew has been shelved. A major LNG complex in Annaba/Skikda is being operated under a management assistance contract with Kellogg.

Goals and Objectives.—The objectives of the Algerians are similar to those of the Gulf States, but terrain, population, hydrocarbon resources, and political outlook differ. The role of chemicals and petrochemicals in Algeria is to: 1) provide added value to their hydrocarbons; 2) provide import substitution; 3) contribute to Algeria's base and future economic development; 4) train a technical class which may either stay in this industry or filter into other parts of society; and, finally 5) in the case of ammonia, to assist in increasing agricultural yields and in deriving export income, since agricultural products are presently a major Algerian import.

Project Organization and Structure.—While as in other countries, studies are prepared prior to a project decision, the absence of joint venture partners and the lack of a technical experienced cadre in Algeria are particularly distinguishing features. Moreover, in earlier projects Algerians were said to distrust contractors and consultants because of limited Algerian technical expertise, language barriers, and infrastructure problems. Much of this is changing, however. Projects are now better defined; Kellogg is providing construction, operating, and training assistance; and a more skilled cadre is emerging to work with contractors. Still, this is an evolutionary process; relatively long construction periods on new projects and less-than-efficient operation (by Western standards) of producing facilities can be expected for many years to come.

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[15] Natural gas when extracted is mostly methane but it also contains higher hydrocarbons such as propane, butane, and ethane which can create difficulties in pipeline transport. Thus the natural gas is first cooled and the higher hydrocarbons are condensed, forming natural gas liquids.

[16] See Nigel Harvey, "Algeria Rethinks Its Petrochemicals Strategy," *Middle East Economic Digest*, Mar. 23, 1984, p. 11; Nigel Harvey, "Algeria Fails To Realize Its Full Potential," *Middle East Economic Digest*, Aug. 12, 1983, p. 49.

Technology Transfer.—Technology transfer is accomplished via contractors installing turnkey projects and training Algerian personnel. In the ammonia and LNG projects, contractors were hired to provide both technology and construction services. Hence, contractor fees were paid rather than licensing fees. Typically, the trend has been for contractors to be hired to operate the facilities and train personnel. Although the incentives for chemical and related projects in Algeria have many similarities to the Saudi projects, technology transfer appears to be less efficient, in the sense that some plants are completed but not operating.

Financing.—Algeria has typically been in a cash-deficient position and has borrowed funds from the international banking community to fund projects. They have frequently obtained favorable loan terms via intergovernmental loans. Moreover, due to Algeria's abundant gas reserves, as compared to crude oil reserves, a major strategy has been to export natural gas in liquid form (LNG) at a price equal to its crude oil energy equivalent (measured in Btu). If this endeavor is successful—and the undersea pipeline to Italy and associated contracts would indicate this—Algeria will increase its ability to finance its economic development.

Socioeconomic Considerations.—The role of chemicals and petrochemicals in Algerian development must be viewed in the context of Algeria's overall philosophy and development program. Since independence, Algeria has tried to modernize with financing from hydrocarbon export revenues, while managing the process through a combination of socialism and Islam. The first development plan of 1970-73 focused on the development of hydrocarbon, chemical, iron and steel, and engineering industries to serve as a base for economic growth. This was followed by a second plan in 1974-77, with emphasis on agriculture, water resources, and a continuation of the previous industrialization program. Unfortunately, in Algeria's attempt to push forward rapidly, infrastructure and human development were neglected. No new plan was initiated until 1980. In the current plan (1980-84), heavy emphasis is placed on infrastructure, housing, agriculture, education, and lighter industry along with some continued thrusts into industrial development. The plan also provides for training young Algerians who can play a role in industry, government, and the army, and for remedying the country's chronic underemployment. Nonetheless, East and West Asian labor is used extensively in construction projects, a function of both Algerian work attitudes and contractor cost concerns. Finally, while economic development is a key incentive for Algerian projects, rules and regulations with regard to Islamic law and the conduct of foreigners are well defined.

Qatar

The small state of Qatar has a population of approximately 220,000, of whom approximately 70,000 are Qataris. Qatar became an independent state in 1971, having been formerly a British protectorate, part of the Trucial states. When the other Trucial states formed the United Arab Emirates, Qatar declined to join.

Petroleum exploration, production, and related businesses are handled by the Qatar General Petroleum Corp. (QGPC). When a decision was made to enter into petrochemical production, the Qatar Petrochemical Co. (QAPCO) was created by the government to handle petrochemical production. CdF Chimie (France) is a 16 percent joint venture partner in QAPCO; the other 84 percent is owned by QGPC.

Qatar is a minor crude oil producer (1981 production rate of 350,000 bbl/d), and its reserves are declining rapidly. However, the country possesses remarkably large natural gas reserves, with the offshore North Field allegedly containing 100 trillion cubic feet (ft^3) of recoverable gas. This substantial position in natural gas underpins the country's future prospects and makes it an attractive market for international process contractors, gas companies, and process companies.

Goals and Objectives.—Qatar has a relatively limited flow of hydrocarbons on which to support its economy. It has therefore selected industrialization and, in this case, petrochemicals to support its development effort. Realizing value for Qatar's flared gas has been an impetus for petrochemical development.

Considering Qatar's size, the country has embarked on a very aggressive industrialization program. In fact, it is the first of the Arab Gulf States to establish ethylene production. Apart from the ethylene, the LDPE plants, and the proposed HDPE facility, it has built a major ammonia/urea complex and a steel plant, all using natural gas. Two gas-processing units strip the gas of ethane for ethylene and LPG, which are then exported. The ammonia/urea complex is owned by QAFCO (Qatar Fertilizer Co.), a joint venture of QGPC and Norsk Hydro (Norway), with minor participation by Davy-McKee (the original U.S. contractor) and Hambros Bank. The steel plant is a joint venture of QGPC, Kobe Steel, and Tokyo Boeki (the latter two Japanese firms).

With the help of the French, Qatar brought onstream the first major olefins derivative project in the region dedicated to the export market. This project represented a major effort by the French Government and CdF Chimie to establish a position in the Middle East. In an arrangement unique among Middle Eastern petrochemical projects, the terms of the agreement called for an investment by Qatar in a French LDPE project located in Dunkirk and a similar investment by the French in the Qatar LDPE project, located in Umm Said. The French Government aggressively pursued the French venture, secured the construction and procurement activities for French-based companies, and realized an inflow of funds from Qatar (QAPCO) as a result of Qatar's 40 percent position in the project. CdF Chimie took a 16 percent position in the Qatari project. France provided export credits and guarantees to help finance the project and exempted QAPCO from French income taxes. The actual inflow of French funds to Qatar was limited, owing to licensing and management fees earned by CdF Chimie. Engineering, construction, and procurement are primarily controlled by French companies. CdF Chimie later declined crude oil entitlements made available because of the pricing of the crude oil and CdF Chimie's lack of adequate handling facilities.

Project Organization and Structure.—As in Saudi Arabia, preliminary studies, feasibility studies, and the like were conducted. Unlike the Saudi Arabians, however, Qatar has taken a major position in its domestic project, as well as a position in its joint venture partner's project in France. Qatar has provided financing for both the Qatar project and the Dunkirk project and is providing low-cost feedstock for the Qatar project. However, Qatar used considerably more commercial financing than Saudi Arabia. The French contributions to the Qatar project are export credits for its suppliers, licenses, management know-how, and marketing. The principles behind the Dunkirk project are similar to those of most joint ventures in the West.

Technology Transfer.—Agreements developed in the QAPCO project that concern technology transfer are similar to those in Saudi Arabia. However, similar to the Saudi/ Mitsubishi agreement, the venture partner, licensor, and construction contractors are virtually all one nationality—in this case, French. CdF Chimie is primarily responsible for all marketing. Since CdF Chimie receives a commission on all sales, it has a continuous incentive to move large volumes of product.

Financing.—The exact nature of the project financing of the LDPE project in Qatar is not known. However, it is thought that France provided approximately $300 million in export credits at rates of approximately 8 percent. Euroloans represented approximately $200 million. This debt was eventually assumed by the Qataris at preferential rates. Nevertheless, since Qatar owns virtually all assets (84 percent) and CdF Chimie has a commission sales agreement and as such is more concerned with sales volume than with a project return on investment, the question of financing is not of critical importance.

Socioeconomic Considerations.—Qatar is a small country which is similar in population and closer in temperment to Bahrain than to Saudi Arabia. Its incentive for an LDPE complex is economically motivated. As such, it has taken an aggressive stance in upgrading its hydrocarbons and establishing with this project a future economic base for its development. It had the first petrochemical project in the region as well as the first Arab investment in a West European petrochemical project. Moreover, it used the joint venture approach towards technology transfer. Whether their arrangement with the French is superior to that established by the Saudi Arabians with others is open to debate.

Bahrain

Bahrain is a small country with a population of approximately 350,000 and declining oil and gas reserves. Future prospects for gas look better than those for oil. As with other countries in the region, Bahrain uses hydrocarbon revenues to ensure a base for future economic development. Bahrain's petrochemical project is unique as an Arab joint venture.

Bahrain's participation in hydrocarbon projects dates back to drilling and exploration activities in the early 1920's. By 1929 the Bahrain Petroleum Co. (BAPCO), a jointly owned entity of Standard Oil of California and Texaco, had built the first oil refinery in the region. A series of negotiations over 30 years resulted in the nationalization of BAPCO to BANOCO (Bahrain National Oil Co.).

Aside from the oil refinery and the proposed methanol/ammonia facility, Bahrain has a gas separation plant and exports LPG. The country is a major Arab banking and recreational center.

Goals and Objectives.—The Bahrain petrochemical project located at Sitra Island represents the first Arab petrochemical joint venture. The project is a joint venture between BANOCO, PIC (Kuwait), and SABIC (Saudi Arabia). Project completion is expected by 1985. In addition to inter-Arab cooperation, the project is stimulated by the fact that Bahrain has a limited crude oil capability to sustain its growth, but has significant quantities of gas.

Project Organization and Structure.—The chemical project was initially an ammonia project. Kuwait, which has considerable experience with ammonia projects, contributed personnel in the early days of the project. These individuals were generally considered to be quite competent. However, as the project progressed and became more complex, a contract estimated at $9 million was awarded to King Wilkinson (U.S.) to help select contractors and technology and generally manage the project. Although based in Houston, King Wilkinson manages this contract from its offices in The Hague. Construction contracting was later awarded to Snamprogetti (Italy), while design and engineering of the methanol and ammonia processes were awarded to Uhde (West Germany).

Technology Transfer.—Technology transfer is being facilitated via the King Wilkinson organization. At its direction, contractors and licensors have been selected, and training programs developed. Technology is simply being purchased in this project. The Arab joint venture participants will be contributing money and possibly some personnel. The structure of marketing and offtake agreements with the joint venture partners has not been published. However, it is thought that GPCO (Gulf Petrochemicals Co.) will market the material. An agreement with an international marketer is also possible.

Financing.—Studies have been conducted and jointly funded. However, at this juncture, technical issues associated with joint venture participation are being considered, particularly by experts at King Wilkinson. The final structure and management roles are not known and are thought to be still evolving. The project is expected to receive equal contributions from the joint venture partners and to provide equal returns. The gas is expected to be priced in a fashion similar to that in Saudi Arabia. Financing reportedly will be provided on soft interest terms, probably in the 5- to 6-percent range by an Arab consortium, with a debt/equity structure of 85/15.

Socioeconomic Considerations.—The country's future economic growth is expected to be based on its growth as a regional banking and commercial center. This is reflected in Kuwait's location of its Kuwait-Asian Bank (to support West and East Asian business) in Bahrain and the large dry dock project recently completed in the country. Chemical projects, such as the ammonia-methanol project, are not expected to play a major role in the country's future economic development. However, this project, like similar projects in the region, will assist in the country's economic growth by efficiently using natural gas resources. It also represents joint Arab participation in the development of a neighbor Arab country. The exact participation of Kuwait and Saudi Arabia in this project is not known since it is currently in the planning stage.

Other Recipient Countries

Iran.—Iran's relatively well-advanced plans for constructing ethylene-based complexes have foundered on a variety of problems. When the Shah of Iran fell from power, Iran had the most developed petrochemical sector in the Middle East region, and the Iran-Japan Petrochemical Co. (IJPC) complex was on the verge of completion. Even in comparison to the various Saudi Arabian petrochemical ventures, this project at Bandar Khomeini (previously Bandar Shahpur) would have remained the most ambitious single project in the region through the 1980's and possibly into the 1990's.

The Iranian chemical industry dates back to the 1960's, when a fertilizer plant was constructed near Shiraz. In 1965, the National Petrochemical Co. (NPC) was created as an autonomous subsidiary of the National Iranian Oil Co. (NIOC). NPC was allowed to enter into joint venture agreements with foreign concerns. In 1969, the Abadan Petrochemical Co. began with 26 percent of its shares owned by B. F. Goodrich. Its main products were PVC, benzene, and liquid caustic soda. Further joint ventures followed, with Amoco and the Cabot Corp. A large fertilizer plant, the Shahpur Chemical Co., started in 1971 as a 50/50 venture with Allied Chemical. Another large joint venture was the Iran-Nippon Petrochemical Co., which entailed cooperation between NPC and the Japanese companies Nissho-Iwai and Mitsubishi Chemical. It began operation in 1976, but owing to financial disagreements, the Japanese stake in the venture had decreased to 30 percent by the time the Shah fell.

The project at Bandar Khomeini is a joint venture of the Iranian NPC and a Japanese consortium dominated by Mitsui. When completed, this venture was to be a sophisticated complex producing ethylene, propylene, butadiene, and aromatics, as well as a variety of intermediate chemicals, with a total capacity of over 1.6 million tons annually.[17] Although this plant would produce a substantial amount of exportable chemicals, it was envisaged prior to the Iranian revolution that the Iranian economy would absorb much of the output of the IJPC venture.[18] This project was conceived in 1969 and construction began around 1971. Construction was halted in 1974 due to cost increases, but resumed in 1976 after project refinancing. Construction was halted again in 1979 because of the revolution.

The Japanese recognized from the beginning the advantages to be gained from cheap gas feedstocks ($0.35 to $0.60 per million Btu) and pursued the Mitsui petrochemical project in Iran as a part of their official oil diplomacy.[19]

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[17] D. T. Isaak, "Basic Petrochemicals in the 1980's," RSI Working Paper, Honolulu, Hawaii: East-West Center, 1982.

[18] Fereidun Fesharaki and David T. Isaak, *OPEC, the Gulf, and the World Petrochemical Market—A Study in Government Policy and Downstream Operations* (Boulder, Colo.: 1983), Westview Press, Inc., pp. 204-205.

[19] Martha Caldwell Harris, "The Dilemmas of Japan's Oil Dependency," *The Politics of Japan's Energy Strategy*, Institute of East Asian Studies, University of California, Berkeley, 1981, pp. 65-84.

The Japanese Government disassociated itself somewhat, and what was once called a "national project" is now called "a nationally supported project."[20] The on-again off-again nature of the IJPC complex and the uncertainties of the Iran-Iraq War make it difficult to predict when it might come onstream. In mid-1983, Iran agreed to take on a larger financial burden, and emphasized completion of 3 of the 13 complexes originally planned.[21] This project will, however, probably be completed someday, since the present Iranian authorities are strongly, committed to developing the petrochemical sector. The new 5-year petrochemical plan is budgeted at nearly $3 billion, which allows for planned renovation of existing chemical units and the commissioning of some new ones (although completion of Bandar Khomeini alone could absorb most of this).

It would probably be a mistake to write off the Iranian petrochemical industry. It should be remembered that despite all the disruption of recent years, chemical plants remain in existence, and some are operational. However, for the present and near-term, dramatic changes are unlikely in the Iranian petrochemical sector. Official commitment to this sector is strong, and the Iranians will probably concentrate on import-substitution in the short run; export-oriented projects are not in the immediate future.

Iraq.—Until the outbreak of the war with Iran, Iraq gave its petrochemical sector a fairly high priority. Iraq used some of its associated gas[22] to produce nitrogenous fertilizers and ethylene and was continuing construction of gas-gathering projects for the South Rumaila fields and for various northern oil fields. In fertilizers, Iraq has the added benefit of having phosphate deposits that could be exploited with mining operations. Rejecting joint ventures in petrochemicals, Iraq emphasizes turnkey plants.

Iraq's problems in the petrochemical sector are similar to those of Iran. Its ethylene complex in Basra is affected by the war. However, unlike the Bandar Khomeini plant, this plant has good prospects for rapid completion after the end or abatement of the war. Present damage to the complex is difficult to gauge. Compared to the IJPC project, the Basra facility is fairly simple, being an ethylene cracker[23] with capacity to make polyethylenes and PVC plastic. It is directed primarily at the domestic market and is solely owned by the Iraq Ministry of Industry. The Basra project has not apparently experienced an exodus of talented technicians and administrators, and thus has a good chance of coming onstream by the end of the decade if the war abates.

Egypt.—As a significant producer of oil, Egypt has the potential to develop a petrochemical industry that could serve its large but relatively poor population. Although Egypt is determined to enter the commodity petrochemical sector, its impact on world markets will be small. The Egyptian Petrochemical Co. (EPC) is planning a two-phase petrochemical project in Alexandria that will result in Egypt's first ethylene-based complex. In late 1982, EPC started awarding letters of intent for this complex. Due to go onstream in 1985, the project will use imported ethylene. Phase one will include production of 80,000 tons/yr of PVC and 60,000 tons/yr of chlorine/caustic soda. The second phase of the project is expected to expand capacity to 100,000 total tons/yr of HDPE and LLDPE and 760,000 tons/yr of LDPE.

Egypt is well established in the fertilizer sector, having ammonia plants at Aswan, Helwan, Tilkha, and Abu-Qir. Together, these have a capacity for 1.1 million tons/yr of ammonia and 950,000 tons/yr of urea. Also, the plant under construction at Abu-Zaabal will produce 218,000 tons/yr of sulfuric acid and 66,000 tons/yr of phosphoric acid. From its West Sebayea mine, Egypt supplies phosphates to the Abu-Zaabal fertilizer plant. Egypt will ultimately become a major end-user of commodity petrochemicals. For now, however, activity in this area is limited.

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[20] Wharton, op. cit., p. 23.

[21] "Iran's White Elephant Limps On," *Middle East Economic Digest*, Special Report on Japan, December 1983, p. 14.

[22] Wharton, op. cit., p. 25. Presently, eighty percent of Iraq's associated gas is flared.

[23] A cracker is used for thermal decomposition of petroleum to extract low-boiling fractions.

ABSORPTION OF PETROCHEMICAL TECHNOLOGIES

Training Programs

Considerable attention is placed on manpower training programs in the various countries examined. As might be expected, the most extensive programs have been instituted in Saudi Arabia. However, the logic behind all the training programs is similar: for true economic development to occur, a team of nationals must be trained to manage, operate, and support industrial growth. The gains derived from manpower training represent a continuous return on investment. For example, SABIC considers personnel training a means for: improving the efficiency of operation and maintenance; using a secured local resource; raising the productivity of employees; and increasing net returns in the long run.[24]

Although the petrochemical plants involved in the Saudi Arabian joint ventures are not labor-intensive, the total number of personnel involved is greater than in comparable U.S. plants. This is because each project, large or small, is an entirely separate company and because SABIC insists that a high proportion (now 75 percent) of the staff should be Saudi Arabians at the time of startup. An inevitable duplication in management and administrative effort results.

SABIC conducts training programs independently and with its joint venture partners, as appropriate. These programs provide both theoretical knowledge as well as on-the-job training. At the end of 1981, 75 percent of the personnel in SABIC joint ventures were reported to be Saudi Arabians. By the time all SABIC projects reach production, 7,000 to 10,000 Saudi Arabians should be employed. (These data include a broad range of projects outside the petrochemical sector.)

Programs conducted by Mobil and Exxon fall within the purview of SABIC. Trainees from Saudi Arabia, of junior high school age, are sent to the United States to take programs in English, science, mathematics, and specific technical skills ranging from welding and machine shop skills to operating engineers. These programs last up to 3 years, of which the last 18 months include on-the-job training. In most training programs, students are housed on campus for a period of time in order to reduce culture shock and introduce them gradually to American culture. (This acclimation period is, of course, not needed for trainees who have gone to universities in the United States.)

Kellogg's program for the Algerians is similar to the program U.S. companies have for the Saudi Arabians; however, Kellogg makes greater use of plant operation simulators. In addition, it also assists in on-the-job training in the Algerian plants.

The Saudis may have comparative success, due to prior experience of some trainees with ARAMCO. In addition, they plan to build a national oil training center to train 300 to 400 students which will contribute to expansion of the technical work force.[25] Eventually,

Photo credit: Mobil Oil Corp.

Saudi Arabian trainees at Mobil's petrochemical plant in Beaumont, Tex.

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[24] SABIC, *5th Annual Report*, 1981.

[25] The $16 million training center will be built in the Eastern Province and three additional centers are planned. See *Middle East Economic Digest*, Sept. 30, 1983, p. 38.

both the Saudi Arabians and the Algerians should be able to operate their own facilities by the 1990's. One concern is whether this will involve excessive requirements for technical manpower, leading to shortages in other sectors. It is likely that foreign training programs with a small core of foreign personnel will still be required initially to help operate the new ventures of the early 1990's.

Inter-Arab Cooperation

Cooperation among Arab nations is another potential method for transferring skills. The transfer of technology or skills from Saudi Arabia or Kuwait to other countries in the region (i.e., Bahrain) seems remote, however, during the 1980's and is probably questionable during the early 1990's. In the Bahrain methanol/ammonia project, it is not clear how future inter-Arab cooperation will progress. It would seem that the major contributions by Saudi Arabia and Kuwait will be financial. Some Saudi management personnel and some Kuwaiti (PIC) personnel may participate in the venture. During the 1980's, however, both countries are expected to be strained for trained personnel even for their domestic operations.

Nevertheless, interest in inter-Arab cooperation in petrochemical development continues. The six-member Gulf Cooperation Council (GCC) recently agreed to work with the Organization of Arab Petroleum Exporting Countries (OAPEC) in energy-related training programs.[26] Joint financing capabilities may be enhanced through the formation of the Gulf Investment Corp. (GIC), set up by GCC states to jointly fund development projects. The rationale for joint training programs and financing is clear, but the question is whether cooperation can be built among nations whose domestic resources are now more constrained.

PERSPECTIVES OF SUPPLIER COUNTRIES AND FIRMS

FOREIGN COMPANY PARTICIPATION

The transfer of technology to the various countries examined in this study can be performed through: 1) joint venture partners, 2) licensors, and 3) contractors. Only Saudi Arabia and Qatar have taken advantage of all three principal mechanisms. The remaining countries, for the products being investigated, have selected only the licensor and contractor routes.

Joint Venture Partners

The foreign joint venture approach is practiced almost exclusively by Saudi Arabia. The principal incentives for foreign partners entering into Saudi joint ventures include profits, crude oil entitlements, and the potential for expanding production and marketing.

The return on equity is expected to reach approximately 15 percent over time. This calculation is based on a number of factors, prime among them being low-cost feedstocks. The principle is that associated gas will be considered to have zero value at the wellhead during the initial years of any consuming project. The consumer at the point of use would pay a charge of: a fixed element, related to the fixed (investment) costs of the gas-gathering project; and an element adjusted to the crude oil price to cover the energy costs of gas gathering and separation. The process of adjustment means that, with time, the energy-related portion of the price will represent an increasing share of the total, and the overall rate of price escalation also increases. In addition, a profit-sharing formula will be applied when the cumulative average return on equity for any consuming project exceeds a specified figure, i.e., one-half of any excess profit will

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[26] "GCC, OAPEC Promote Energy-Related Cooperation," Kuwait *KUNA* in English, Dec. 26, 1982, reported in F.B.I.S. *Daily Report—Middle East and North Africa*, Dec. 29, 1983.

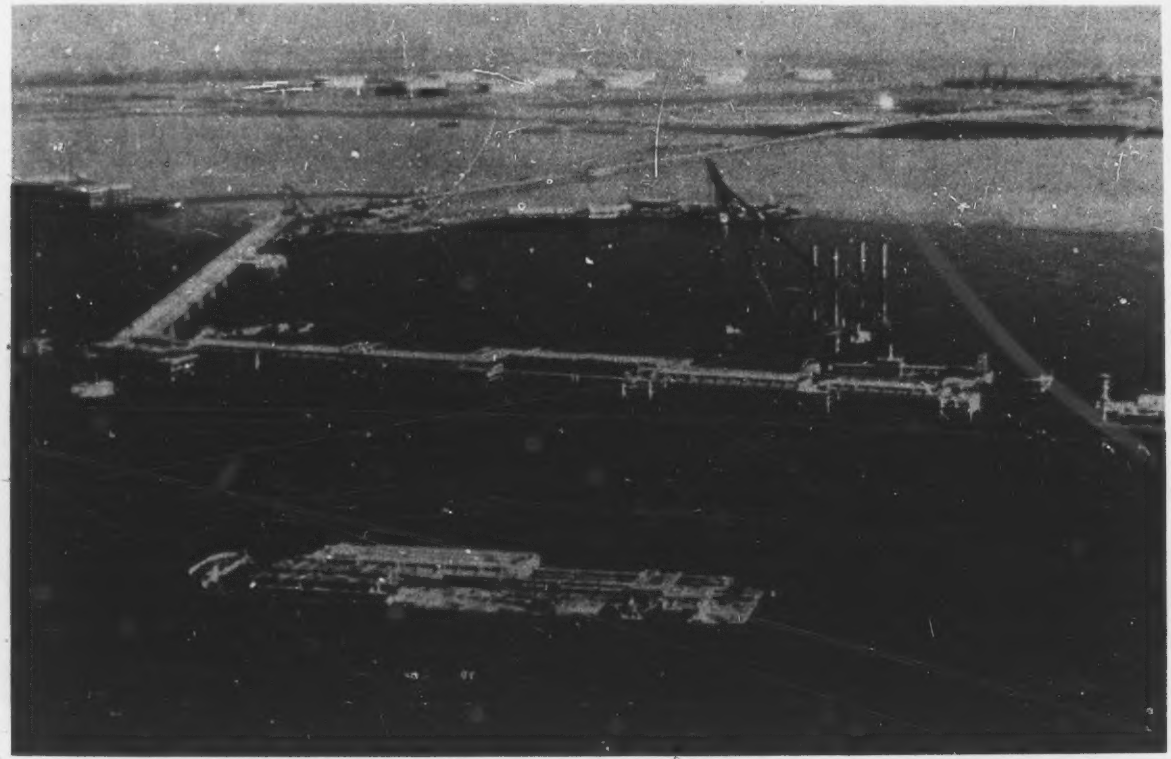

Photo credit: Aramco World Magazine

Marine terminal at Yanbu, Saudi Arabia, from which first west coast shipments of Saudi gas were made in 1982

be taken by the gas supplier, Petromin. A second factor in the calculation of return on investment is low-cost debt. Financial provisions involve coverage by Saudi Government loans at favorable rates of interest: 3 to 6 percent interest on the approximately 90 percent of debt provided by Saudi Arabia. Commercial rates would apply for the remaining 10 percent of debt provided by commercial institutions.[27] Finally, return on investment is enhanced by assistance provided by recipient governments in infrastructure development. At Al-Jubail and Yanbu, the Saudi Government is responsible for the investment burden for site development, infrastructure, and major utilities. However, operating companies will be charged by the Royal Commission on a commercial basis for services provided. The operating companies include the entire joint venture, one-half of which is Saudi Arabian.

A second general incentive has been access to crude oil. Crude oil entitlements authorize the foreign partner to receive a guaranteed supply of crude oil at a commercial price and of an amount related to the partner's investment in the project. Crude oil entitlements appear to have been a major incentive to foreign partners, particularly oil companies such as Shell Oil, which has no share in ARAMCO, and Mobil, whose share is only 15 percent. In the present climate of crude oil supply and demand, the value of crude oil entitlements is questionable. However, long-term security of crude oil supply is still an important objective for these companies.

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[27] Foreign partners will enjoy a 10-year Saudi Arabian tax holiday on their share of net income from the joint ventures. However, under U.S. tax law, American companies are unlikely to derive much benefit from this provision, since the earnings are subject to foreign source income rules.

Finally, foreign companies expect to expand their production and market reach through participation. The companies establishing production bases in the Middle East have diversified their sources of product supply to a location that will facilitate their marketing operations in Southern Europe, Africa, and Asia. Also, from a long-term perspective, they are in a region where the next generation of competitive facilities will be located. The value on contracts won by C. F. Braun since its parent company (Santa Fe International) was purchased by KPC was reported at $3 billion.[28]

From the perspective of the supplier firms, the major impediments to the success of joint venture projects are risks, which could arise from: 1) revolution and the rise of an anti-Western government, 2) industry nationalization, 3) insistence that indigenous personnel operate the facilities before they are ready, thereby reducing efficiency of operations, 4) requirements to market the product in international markets at depressed prices, and 5) fixed crude oil prices regardless of (lower) spot market prices.

While these risks arise whenever a project is considered in a developing country, the large number of projects in Saudi Arabia multiply the risks from a national point of view. Some companies have chosen to proceed after negotiating to soften the risks (i.e., renegotiating crude entitlement agreements, raising profitability goals, eliminating take-or-pay product contracts). Access to crude oil clearly tipped the balance in favor of many decisions made during the 1970's.

All U.S. companies participating in Saudi joint ventures are major oil or chemical companies. In terms of total investment, most are the former. As publicly held corporations, all have, as their long-term objective, the maximization of return to shareholders. Some of the most important considerations influencing U.S. investments in these joint ventures include: 1) the addition of long-term supplies of imported crude, 2) repatriated profits from handling and/or producing this crude, 3) royalties to U.S. licensors, 4) profits to U.S. contractors involved in engineering and construction, 5) repatriated dividends from Saudi Arabian joint ventures, and 6) net receipts for technical and commercial services rendered to the venture, representing a net foreign exchange gain even in a no-profit situation.

The most serious factor now working against a joint venture partner relationship for a U.S. firm is the potential for reduced sales in other non-Middle East markets. In the Saudi-type joint venture, the foreign partner will be expected to provide 70 to 90 percent of the market opportunity, mostly on a committed basis. In the present climate of low market growth for petrochemicals, commitment to market large quantities of petrochemicals produced in the Middle East could limit production in older facilities elsewhere in the world. Clearly, there are cases where a market can be better serviced from the Middle East than from the United States or elsewhere. In such a situation, the U.S. partner's share of the net income may exceed that to be gained from locating in the United States. Finally, there is the argument that if the company does not engage in the joint venture, another will.

In the case of Mobil Oil and Exxon, objectives are clear. These firms seek to maintain their relationships with the Saudi Arabians, obtain crude oil entitlements, expand their position in global petrochemical trade, locate petrochemical facilities in areas providing a long-term advantageous cost position, and realize an acceptable return on their investments. Nevertheless, in the slack oil market of 1983, these firms were in a difficult situation, partly because of their commitments to these ventures.[29]

No West European companies participate in Saudi petrochemical joint ventures. However, the previous discussion about U.S. involvement will apply qualitatively to any future West European activities, though in some cases (West Germany and France in particular), there is likely to be a stronger bias toward the use of home-based contractors and equipment suppliers.

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[28] Shaikib Otaqui, "Petrochemicals Award Strengthens Braun's Kuwaiti Presence," *Middle East Economic Digest*, Aug. 13, 1983, p. 26.

[29] See "Mobil's Costly Saudi Strategy," *Business Week*, Oct. 17, 1983, p. 76.

In the case of Qatar the French company CdF Chimie is the joint venture partner. Its objectives, and those of the French Government that promoted the arrangement, were to expand global market position, minimize cash outflow while maximizing revenues from a low-cost source of polyethylene, acquire financial infusions for a new domestic operation from a source that would not interfere with French management of the facility, gain oil entitlements, and secure a position for French contractors in a Middle East project. In this case, the French Government and the French firm perceived their interests to coincide.

Japanese involvement in Saudi Arabia arises from objectives similar to those of the French in Qatar. The Japanese, however, did not exchange management fees and royalty payments for hard investments. Similarly, they will be responsible for profits and losses on an equal basis and will not, as in the French case, realize commissions on sales. Alternatively, and unlike the U.S. example, Japanese firms have, with their government's support, put together contract packages that involve Japanese partners, licensors, contractors and equipment suppliers. This approach has been relatively successful in the case of the Saudi Methanol Co. There has been less success in the case of SHARQ (the SABIC/Japanese olefin-based complex). Mitsubishi, the lead Japanese operator, has been forced to go through the motions of competitive assessment or bidding for both technology and engineering. The approach of the Japanese Government and Japanese companies differs fundamentally from that of the United States. Japanese Government agencies are active participants in both the Japanese consortia involved at Al-Jubail, and these ventures were planned with the national interests of Japan uppermost.

Licensors

Much has been written about product lifecycles and the tendency of multinational corporations to exploit developing countries through the licensing of inferior technologies. The petrochemical technology licensed to the countries examined in this study is, however, state of the art. Moreover, the intense licensing activity in the Middle East reflects the viability of the market for petrochemical technology.

Technology is licensed in two ways. In one case, a licensor makes an arrangement with a licensee. In the other, the contractor includes the technology as part of the total project package. Appendix 5B includes information about major technology licensors in the Middle East.

Licensors operating in the Middle East are more often faced with incentives than with impediments in transferring technology. Firms such as Union Carbide and Scientific Design established the goal long ago to sell as many licenses as possible. Profits are the central motive, with fees negotiated separately in each agreement. Infrastructure and operating conditions are not major concerns. Training considerations are factored into the fees while market forces determine the value of the technology. With the slowdown in new capital investments in the West, the less developed countries—in the Middle East particularly—represent a primary market for Western petrochemical technology sales.

The only risks for technology licensors are the possibilities that licensing agreements may be broken or that a foreign licensee may penetrate domestic markets. However, since the technology provided is state of the art and is sold at internationally competitive prices, there is no incentive for Middle Eastern producers to break a licensing agreement by sharing the technology with others. Moreover, although these countries have the funds to support the licensing fees, they will not have the research and design capability in this decade to modify or improve a licensed technology to the point where they can claim they no longer need the license because they have their own technology.[30] Finally, every indication suggests that they want to be accepted as full partners in the international business community, a desire that would not be fostered if they were to break licensing agreements.

In the case of market penetration by a licensee, the risks are weighed when the corporate entity decides to market its technology aggressively. Hence, Union Carbide will market its LLDPE technology to all interested partners, while Dow is more selective in which LLDPE technology it promotes. The incentives to U.S. firms for allowing the licensing of chemical process technology are revenues from royalty payments and the maintenance of good government-to-government relations, the latter also important to the U.S. Government.

Generally speaking, there is little difference between petrochemical technology available from the United States, Western Europe, or Japan. Hence, technology is made available globally on a competitive bid basis. U.S. firms have some of the best chemical process technology in terms of performance and cost; but, other good sources of the technology are available to Middle Eastern countries. The technological reputation of certain suppliers gives them a definite competitive edge: 1) Kellogg of the United States for ammonia plants, 2) Imperial Chemical Industries of the United Kingdom for methanol plants, 3) Dutch State Mine Co. for urea fertilizer plants, and 4) Union Carbide for the production of LDPE. Certain European firms (Dow Chemical Europe and Charbonnage de France) have adapted the Union Carbide technology and can be expected to give Union Carbide strong competition.

The contents of the various licensing agreements are generally confidential and are often negotiated differently for each agreement. However, in the case of LLDPE, sufficient information is public knowledge to serve as a model of how these agreements operate and to indicate the magnitude of the revenues associated with them. Union Carbide Corp. has licensed LLDPE technology to an estimated 30 companies worldwide. Its cost to develop this process is not known. However, its revenue structure is thought to include a $100,000 fee and a secrecy agreement just to review the details of its process. If a potential client company wants to purchase the license, it is charged $18 million to $25 million up front for the process license. In addition, a royalty payment of 2 to 4 percent of net sales is paid over a 10- to 15-year period to the licensor. In some arrangements the licensor has an agreement to share new resin breakthroughs with the licensee, and if the licensee develops resins with new properties, it must share them with the licensor. Training programs and startup assistance are provided. Union Carbide does not usually take an equity position in a project in lieu of its fees. With this structure, a licensee producing 200,000 metric tons per year of LLDPE and selling it for $551/ton (25¢/lb) on a constant dollar basis might provide Union Carbide with revenues of $21 million up front and approximately $3.3 million a year (3 percent of net sales) for 15 years or approximately $70 million (in constant dollars) over the time period. Union Carbide is the licensor of LLDPE technology for all SABIC projects. Its specific terms with SABIC are not known.

Engineering Contractors

An engineering contractor is relatively far removed from the decisionmaking processes involved in a manufacturing joint venture. It is unlikely that refusal by a U.S. contractor to bid for, or even to license technology for a prospective project would influence the decision to go ahead with the project. The only decision open to the contractor is whether to bid for the contract or leave it to others.

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[30] The OPEC countries are limited by their weak technical capabilities in petrochemical industry development. See K. Nagaraja Rao, F. Baddour, and Christopher T. Hill, "Strategic Aspects of Chemical Industry Development in Rapidly Industrializing Nations," *Technology in Society*, vol. 4, 1982, p. 153.

A contractor's reasons for operating in the Middle East are fees, the slowdown in major global projects outside of the Middle East, a desire to increase or create market share in this region, and the need to develop a regional track record for consideration in future projects as well as for projects in other developing countries. Most major engineering contractors view their projects from an international perspective. Thus, they tend to view risk more according to which bank or institution is securing their payment, rather than to the specific project location. Also, their fees take into account the complexity and risk involved in working in a developing country.

Based on profit concerns and procurement bidding pressures by the host governments, subcontracts and equipment purchases can frequently be made from a large number of companies worldwide. Hence, the actual value of dollars flowing back to the prime contractor may not be anywhere near the total value of a given project. The typical cost structure associated with a capital project is 45 percent for procurement, 24 percent for construction, 10 percent for design and engineering, and 20 percent for owners' costs, fees, and contingencies. (This will vary somewhat, depending on the project specifics.) The actual fees or profits earned on these projects by contractors are thought to be ± 3 percent of all tangible costs. Contingency costs tend to be greater on lump sum contracts than on "open" or "cost plus" contracts.

Since a Middle Eastern project will in most cases involve competitive international bidding for each major phase of engineering, construction, and procurement, there is no guarantee that the establishment of a managing contractor of U.S. origin will lead to detailed engineering and construction contracts for U.S. companies, and still fewer guarantees for procurement from U.S. suppliers.

Thus, although there may be some bias toward U.S. contractors and suppliers arising from a U.S. prime contract or from U.S. reputation and skill, the main benefit is from the revenues and profits gained by the prime contractor. Many of the Middle East contracts are very large, which is reflected in the contractor's fees. On the other hand, there has been, and probably will be in the future, strong pressure for fixed price contracts or contracts with a guaranteed maximum. If this is the case, the risks to U.S.-based contractors will be relatively great. Nevertheless, Japanese and West European firms are prepared to bid on this basis if U.S. companies choose not to bid.

Requirements To Modify Technology and Project Approach

Operating in Middle Eastern or other developing countries requires a reexamination of approaches that U.S. engineering contractors have utilized in projects in the West. Major differences include the nature of clients, scale of operations, lack of infrastructure, and availability of local skilled manpower.

Typical projects in the industrial nations result from the needs of clients which are usually major operating companies with extensive experience with these types of facilities. This experience of client companies tends to minimize contractor involvement with the recruitment and training of operators, maintenance, and management personnel. In addition, while the startup and operating capabilities tend to reside with the client, the contractor must meet various performance guarantees.

In the Middle East, the clients are typically either joint ventures of the operating company and host government national firm, or a government-related national firm alone. In both situations the contractor can be called on to provide special services not normally performed by a contractor in industrial countries. For example, hiring and training of operating and maintenance personnel may be carried out by the contractor. In addition, a contractor may provide personnel to assist in the startup and early operation phases; in some instances, contractors even operate the plant for an extended period of time. For example, very close coordination with SABIC is maintained by Fluor, Lummus, and Bechtel in their respective projects to assure the proper development and startup of the projects. Lummus is also playing an important role in developing process simulators for training Saudi Arabians. In the case of Bahrain, contractor operators may continue for some time. Algeria continues to use Kellogg's assistance in its ammonia and LNG facilities.

The projects in the Middle East are quite significant in size. The Saudi Arabian industrialization program is probably the largest program of its kind ever undertaken. Such programs require the mobilization of large numbers of people and huge quantities of material and require new management approaches and strategies for projects such as the transformation of Al-Jubail and Yanbu into modern industrial cities. The scope of these projects is so vast that no single contractor can provide 100 percent of the services necessary. Hence, while the large management contracts have been given to American firms, many subcontracts have been let to Japanese, South Korean, and firms from developing countries due to their low labor costs and limited infrastructure requirements.

Most of the areas in which these industrial projects are located lack developed infrastructure. Port and road facilities, housing, hospitals, schools, pipelines, maintenance shops—all of which add to the complexity of the venture and require contractor adaptation—must be built in conjunction with the projects.

Since the major planned construction sites in Saudi Arabia are in remote locations and the size of the work force to be employed is large, there has been a need to provide extensive auxiliary facilities. Harbors, roads, housing, and recreational facilities have been built. Other projects have included the gas-gathering system, a major desalinization effort, significant increases in electrical production in the eastern province, and building crude oil and natural gas pipelines across the desert from the Persian Gulf to the Red Sea. The effective advance provision of these infrastructural facilities has allowed the contracting work on the Saudi petrochemical projects to proceed more rapidly than originally expected and at a lower cost.

The ability to coordinate the numerous activities required in building large-scale projects in remote locations is an art that has been developed through many years of experience by major contractors. In virtually all cases, there has been a need to establish a supply system and to recruit personnel from a variety of nations, presenting formidable obstacles to construction efforts. Major U.S. companies have service divisions that support operations managed from the United States and are also capable of undertaking certain projects independently. These overseas facilities enable firms to procure required materials and equipment on a worldwide basis and to maintain sophisticated computerized inventory procedures for managing the large stocks of necessary supplies.

Remote locations also necessitate modified engineering approaches. For example, modu-

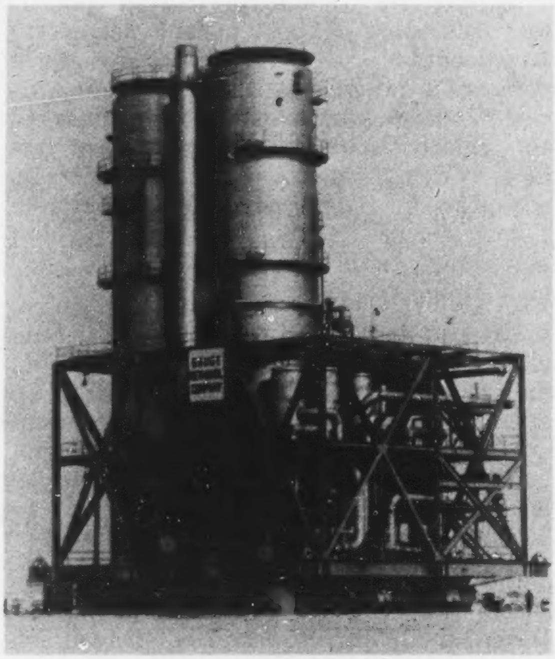

Photo credit: Middle East Economic Digest

Modularized methanol facility, supplied by Mitsubishi (Japan) larization and barge-mounted construction techniques are two modifications that are becoming more commonplace. In one petrochemical project, Bechtel subcontracted the modularization of many of the process components to Belleli of Italy. Mitsubishi modularized much of its methanol facility and then shipped it to Saudi Arabia. The roads in Saudi Arabia have been specially built to handle these unusually heavy loads.

Manpower is another key consideration in remote locations. For many projects, work forces from many countries have been gathered. The major contractors have developed relationships in many countries and have the ability to directly hire needed individuals. Frequently, subcontracts are let to Japanese or South Korean firms who bring in large numbers of Asian employees for a given period. These subcontracts are normally cost-effective and have the virtue, from a Saudi Arabian perspective, of using imported labor, managing it within a small perimeter, and then reducing the labor force when the construction phase is complete. Asian labor has been used in virtually all projects examined in the Middle East and North Africa.

With the exception of Algeria, all the countries examined in depth with regard to petrochemicals have relatively small indigenous populations and a general dislike by the local population of manual labor. Therefore, contractors must recruit crews, operating labor, management, and maintenance personnel from many nations.

Almost all engineering and management personnel in these petrochemical projects are from the United States, Western Europe, and Japan. Field construction forces and maintenance and operating crews come from either the host country or countries such as India, Pakistan, Egypt, Indonesia, South Korea, Turkey, the Philippines, Taiwan, and Thailand. Many of these work crews have at least some experience.

All major contractors are willing to work with local contractors and individuals depending on specific conditions. This approach seems to be working well in Saudi Arabia, while in Algeria, due to English language problems, it has reportedly led to additional inefficiencies. Training is a key issue. U.S. contractors provide training programs that extend to all skill levels. In Algeria, Kellogg has trained field crews in basic construction skills (welding, pipefitting) and is also providing basic elementary education in mathematics and science.

In many instances, construction personnel are subsequently transferred to maintenance groups after additional training. Contractors arrange for vendor personnel to provide training in specialized equipment such as pumps, compressors, and turbines. In addition, supervisors receive onsite training and the contractor typically works with local supervisors through the precommissioning phase.

The lack of fully experienced local labor forces, coupled with the multinational nature of their work forces, presents both cost and efficiency problems for Middle Eastern countries. The productivity of work crews from local or developing country firms may be lower than that of comparable U.S. and/or West European and Japanese work crews. Meeting work schedules may consequently be a difficult task for contractors.

The design of facilities in these often remote locations, which often experience either extreme or unusual weather conditions (e.g., sandstorms, high heat, and humidity) and are subject to labor force constraints, sometimes involve nontraditional approaches. In some cases, different construction materials or backup facilities are required; in the case of a petrochemical complex, decoupling operations are generally incorporated in process designs. Modular or prefabricated construction techniques are often utilized to minimize field assembly. Contractors must also design with an eye toward ease of maintenance and toward limiting the risk of extended downtime.

Contractors generally prepare complete lists of required spare parts and review them with clients. If the buyer agrees, the contractor will arrange for all parts to be delivered onsite. In some instances contractors provide preventive maintenance schedules and computerized inventory control procedures.

Most contracting firms are willing to assume the maintenance responsibility for a facility during its operating phase. However, this service is generally not sought. If a plant were to face serious maintenance or spare parts problems, the contractors would be willing to provide assistance for operating a plant they built. In most countries in the Middle East, operating maintenance has been a problem.

THE ROLE OF U.S. FIRMS IN COMPETITION AMONG SUPPLIERS

Factors that influence the choice of one supplier over the other include: 1) cost/financing, 2) technological differentiation, 3) track/record experience, 4) marketing, 5) scope of services (including training), 6) political/historical ties, and 7) effective use of local agents. In the Middle East, training, experience, and effective use of local agents (for joint ventures) have been particularly important.

U.S. companies are major project participants in the Persian Gulf and Algeria, and compete on all three levels; namely, as operating-joint venture partners, as licensors, and as engineering contractors. The ability of U.S. firms to compete on these three levels reflects their major strengths in marketing and sales, technology, management techniques, and plant operating skills. Japanese (methanol and olefin derivatives) and Taiwanese (fertilizer) participation in projects in Saudi Arabia reflects the desire of Saudi Arabia to diversify its mix of venture partners and aggressive supports by the supplier governments.

In the case of CdF Chimie in Qatar, the French Government actively pursued the project, seeing it as a national priority. At the time, few U.S. companies were interested, partly because of their extensive involvement in Saudi Arabia.

The case of licensors is similar to that of operating companies. U.S. firms have a well-known technical expertise. U.S. technology produces quality products at low prices, as illustrated by polyethylene and ethylene glycol technologies provided by Union Carbide and Scientific Design in the Mobil and Exxon projects in Saudi Arabia and the Kellogg ammonia technology used in Algeria.

Contractors face intense competitive pressures, owing to the sheer size of the projects in which they participate. In the projects examined here, U.S. companies have been a dominant force. However, substantial subcontracts and procurement agreements were also given to other foreign companies because of lower costs (often reflecting lower labor rates).

While U.S. companies exhibit many strengths when bidding against foreign competitors, they also have certain disadvantages. These have included tax and export financing policies.[31] Saudi Arabia provides a 10-year corporate tax holiday. U.S. companies are taxed by the U.S. Government on this income as foreign source income, while their competitors are not. To put it another way, other supplier governments subsidize projects through tax exemptions. Saudi Arabia does not charge an income tax on foreign employees working in the Kingdom. U.S. employees are taxed in the United States on their foreign income (above a certain level). A higher wage scale has sometimes been paid to compensate for this factor. It should be noted, however, that U.S. tax regulations have recently been liberalized in favor of the overseas employee. Companies from Japan and France have more aggressively pursued overseas petrochemical projects with government financial support. Export financing has not, however, been a major factor in awards of contracts in the Gulf States since they have had the capital to finance projects themselves.

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[31] Other concerns expressed by U.S. companies relate to the Foreign Corrupt Practices Act and antiboycott legislation. However, in the analysis performed, no projects were identified where a U.S. company actually lost a bid because of these laws.

In the final analysis, strong and friendly relations between the United States and Saudi Arabia have been an important factor, setting a context for extensive involvement by U.S. firms. At the same time, the standing of U.S. firms as technology leaders has also been a key factor, although the advantages accruing from this technological lead have been gradually eroding.

LONG-TERM DEVELOPMENTS

GENERAL TRENDS

The petrochemical industry is presently undergoing a difficult restructuring process, resulting from stagnant demand and uncertain growth prospects for petrochemicals and feedstock costs. This situation will be further exacerbated by the entry of Middle Eastern and other new producers—with their relatively inexpensive feedstocks for methanol, ammonia, and olefin derivatives based on natural gas and on natural gas liquids recovered from associated gas.

The petrochemical world was less complex in the 1970's, when there were, in essence, three major areas of petrochemical production and consumption: the United States, Western Europe, and Japan. These areas represented 63 to 65 percent of world demand, as well as 68 to 70 percent of the world production. Manufacturers in these large homogeneous market areas were able to construct large-scale plants. In addition, feedstocks were readily available at sufficiently attractive prices to enable manufacturers in these regions to import feedstocks for conversion to intermediates and final products. Often, intermediates were exported for conversion to polymers. These products were ultimately upgraded into fabricated products for consumption in the manufacturing area, or reexported to the three major economies.

Since the oil crises of 1973-74 and 1979, significant changes have been occurring in the global manufacture, as well as consumption, of the key petrochemicals. Four more major geographic entities are likely to become more important sources of petrochemical intermediates and derivatives: Canada, Mexico, the Middle East, and Southeast Asia. The Canadian and Middle Eastern developments will have the most significant impact on global trade in the mid-1980's. From Canada, manufacturers will export very significant volumes of methanol, ammonia, and ethylene derivatives. The Mexican petrochemical industry will send petrochemical derivatives to the international market. Major petrochemical centers in the Middle East, previously discussed, will come onstream during the 1980's and will export products. Finally, Southeast Asia (the ASEAN countries of Thailand, Malaysia, Singapore, and Indonesia) will become an increasingly important center of petrochemical production, consumption, and exports during the late 1980's. During the mid to late 1980's, ASEAN projects will come onstream competing with products from the new export centers of the Middle East and Western Canada in market areas once dominated by products produced in the United States, Japan, and Western Europe.[32] A major question is what effect the new petrochemical projects in the Middle East will have on producers in the United States and elsewhere.

THE RESTRUCTURING OF GLOBAL TRADE IN COMMODITY CHEMICALS

Since the majority of the petrochemicals to be produced in the Middle East and the products of most concern to world market trade

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[32] While the feedstock base of this Southeast Asian region will not be as favorable as that anticipated for the Middle East and Western Canada, Southeast Asia will be a significant domestic market. Also, Southeast Asia, being on the prime shipping lane between the Middle East and Japan, has a strategic location, and all material that will likely move from the Middle East to the Pacific will pass the proposed petrochemical complexes of Southeast Asia.

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are commodity chemicals, OTA analyzed prospects for market restructuring in several of these chemicals: polyethylene, ethylene glycol, styrene, methanol, and ammonia. The analysis covers the decade through 1990.

Factors such as global economic performance, oil price trends, and a variety of political and other issues affect the global development of the petrochemical industry. Specific developments in each country combine to determine future trends in demand, supply, trade, and prices for each product. In order to anticipate the positions of Middle East petrochemical producers in world trade, global and country-specific demand for each type of product was first considered. (App. 5C includes tables showing these demand expectations.) Domestic supply in each country was assessed by considering available capacity, production economics, market demand (local and export), and plans for new/expanded capacity.

From these national and regional projections of demand and supply, preliminary global balances were developed for each petrochemical product. These highlighted possible imbalances in the future world supply/demand position. In practice, apart from minor inventory swings, global supply must balance demand in each year, and there must be zero net global trade. Thus, a projected potential global oversupply in the near future must be primarily accommodated by reduced operating rates in high-cost exporting regions such as Western Europe and Japan.

It should be noted that many factors affect different countries' petrochemical product competitiveness: 1) raw materials/feedstock price and availability; 2) size of the domestic market and economies of scale; 3) exchange rates; 4) R&D capabilities relative to new and improved products and process technologies; 5) investment levels in new plant and equipment; 6) government actions that increase the price of petrochemical products at home and abroad (e.g., taxes on raw materials or petrochemical products) or actions that assist, protect, or subsidize the domestic petrochemical industry; 7) regulatory impacts and cost; 8) labor costs—as determined by availability and skills; 9) profitability—return on investment; 10) marketing strategies and distribution systems; 11) energy fuel use and costs; and 12) capacity utilization—or production efficiency/productivity.[33] On most of these counts, the U.S. petrochemical industry has some special strengths.

The analysis that follows indicates that the impact of Middle Eastern petrochemicals on the U.S. market will probably be concentrated on a relatively few products. According to one forecast, in 1990 products produced in Saudi Arabia will win a relatively small share of the U.S. market: 1 percent of LDPE, 0.5 percent of HDPE, 3.6 percent of ethylene glycol, 8.6 percent of methanol, and 5 percent of styrene.[34] While U.S. specialty chemicals may actually gain strength, the United States will become a net importer of ethylene glycol and methanol, mostly from Canada. The negative impacts of petrochemical trade restructuring will be felt especially in Japan and Western Europe. Map 4 shows the location of major projects and projected production capacity for 1990.

Low-Density Polyethylene/ Linear Low-Density Polyethylene (LDPE/LLDPE)

Total free world consumption of LDPE, including linear material, was 9.8 million tonnes in 1981. The industrialized regions, defined here as Western Europe, North America, and Japan, accounted for 79 percent of this total. By 1990, total consumption is anticipated to reach 15.6 million tonnes, with the industrialized regions' share declining to approximately 72 percent. By the year 2000, the industrialized regions' share of total consumption may recede to approximately 65 percent.

Global growth rates will be relatively high for this product owing primarily to expected rapid growth in consumption in the developing regions. Table 43 shows the varied uses of polyethylene products. In these countries

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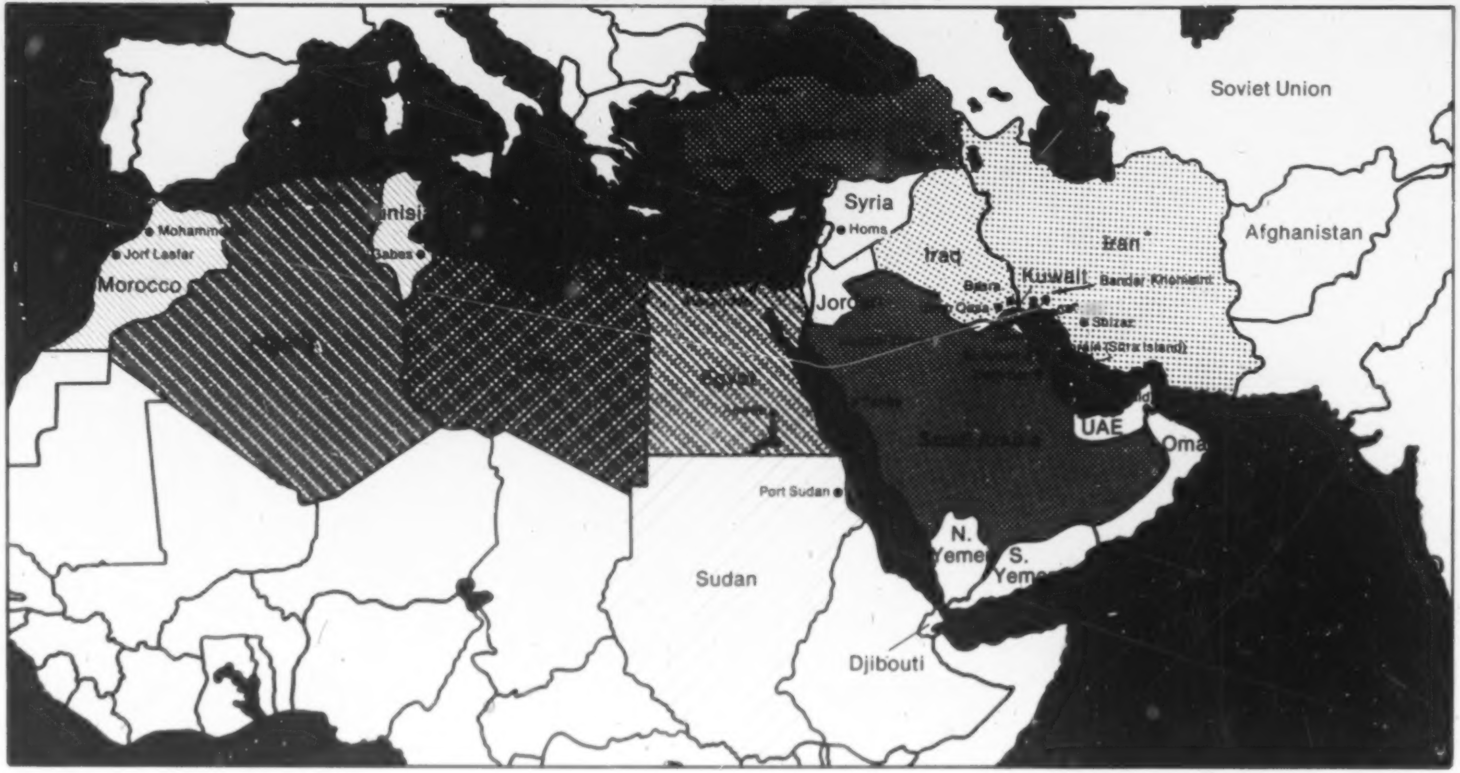
[33] U.S. Department of Commerce, *A Competitive Assessment of the U.S. Petrochemical Industry*, Office of Competitive Assessment, Washington, D.C., Aug. 31, 1982.

[34] Wharton, op. cit., pp. 67-68.

Map 4.—Petrochemical Production in the Middle East and North Africa (location of major projects; projected production capacity for selected petrochemicals in 1990)



Key: • Location of major petrochemical projects

Projected capacity of LDPE and LLDPE by 1990 (1000 metric tons per year)	Projected Methanol Capacity by 1990 (1000 metric tons per year)	Projected Ammonia Capacity by 1990 (1000 metric tons N)
☐ 1-50	☐ 1-100	☐ 1-250
░ 51-100	☐ 101-350	☐ 251-500
▒ 101-150	▨ 351-600	▧ 501-750
▓ 151-200	▨ 601-1000	▧ 751-1000
■ More than 200	☐ More than 1000	■ More than 1000

*Iran's projected LDPE/LLDPE capacity depends entirely upon completion of the Bandar Khomeini project, where work remained suspended as of 1984.

NOTE: The delineation of boundaries on this map must not be considered officially accepted. Geographic names or their spellings do not necessarily reflect recognition of the political status of an area.

SOURCE: Office of Technology Assessment.

Table 43.—Middle East Petrochemical Product Uses

Petrochemical products:
Uses in various industrial and consumer products

1. ***Polyethylene:***
    - Low-density polyethylene (LDPE)—plastic bags, agricultural films
    - Linear low-density polyethylene (LLDPE)—tourist gift bags, films, moldings
    - High-density polyethylene (HDPE)—sewer and drain pipes, wire and cable covering; household chemical and food bottles; replacement of ½ gallon paper milk containers; injection molding of beverage crates, paint cans, food containers and base cups for polyethylene terephtahalate (PET) bottles; heavy-duty film for food packaging bags.
2. ***Ethylene glycol:***
    - Used in polyester apparel; antifreeze/coolant; production of PET
3. ***Styrene:***
    - Used in polystyrene plastics and synthetic fibers
4. ***Methanol:***
    - Used in gasoline octane boosters, deicers, and other fuels; in thermoset resin adhesives used in plywood and chip wood industries; in resins such as DMT used in the production of polyester fibers and films. Used in production of formaldehyde.
5. ***Ammonia:***
    - Used directly
    - Used in fertilizers (including urea), synthetic fibers
    - Industrial uses in fiber, resin, and elastomer intermediates; explosives, livestock feed supplements

SOURCE: Office of Technology Assessment.

paper and other competing materials will be replaced by LDPE/LLDPE, and market stimulus will be provided by new local production of petrochemicals, and growth in exports of finished products to the industrialized countries. Market growth in the industrialized regions, particularly in Western Europe and Japan, will however be limited by slow economic growth, market maturity, downgauging (use of thinner film), and growing imports of finished products from the developing regions.

The global supply pattern for LDPE/LLDPE will change dramatically over the next few years. Table 44 shows that the most rapid increases in supply will be in the Middle East, which is developing several export-oriented projects. In addition, Canada is also developing export-oriented projects with a focus on Pacific Basin markets; and Latin America and Southeast Asia producers will expand their capacity to meet increases in domestic demand and, in the case of Southeast Asia, for export.

Table 44.—LDPE/LLDPE Net Interregional Trade (thousand metric tons)

	1981	1985	1990
Western Europe	323	—	(100)
North America:			
United States	424	180	15
Canada	84	270	455
Japan	135	30	(180)
Pacific Basin and Indian Subcontinent	(284)	(253)	(235)
Latin America	(293)	(180)	(498)
Africa	(216)	(182)	(58)
Middle East	(81)	110	641
Eastern Europe	100	125	110
People's Republic of China	(100)	(100)	(150)
Total	92	—	—

NOTE: Parentheses indicate net imports.

SOURCE: Office of Technology Assessment.

Because of the increasing economic advantages enjoyed by producers with access to low-cost ethane feedstock, the overall level of interregional trade in LDPE/LLDPE will grow, and the pattern of trade will change significantly, as shown in table 44. It is anticipated that: 1) Western Europe and Japan will become major net importers, a reversal of their traditional positions; 2) Latin American imports will probably grow significantly since local production will be unable to keep pace with demand and many of these countries do not have the resources to support local production; 3) Southeast Asian projects will "backout" some exports from the Pacific Basin but will be unable to balance regional demand; 4) Canadian exports will grow, despite the current project development delays; and 5) Middle Eastern exports will grow to dominate global trade patterns, with continuing project development expected in the 1990's after the current round of projects is completed.

The major factor in the U.S. domestic LDPE market is the impact of LLDPE rather than any major import threats. The competitive effect of LLDPE will be felt most strongly in the film area, where LLDPE offers excellent properties. Thus, a gradual decline in the importance of LDPE over the period can be expected. At the present time, the demand for LLDPE is limited by supply, while U.S. producers now have more than enough plant capacity to meet current and future demand for LDPE. The decline in consumption forecast for LDPE indicates that producers will probably convert some of their capacity to LLDPE. Also, plans for producing LLDPE in Western Canada could relieve potential shortages of LLDPE in the United States. It is anticipated that the United States will retain a net positive trade balance in LDPE/LLDPE during the forecast period; however, U.S. exports are expected to become marginal because of the emergence of major export-oriented facilities in Western Canada and the Middle East.

While material produced in Canada and the Middle East is not expected to penetrate the U.S. domestic market significantly,[35] it is expected to expedite the conversion of much of the U.S. industry to LLDPE. Other segments of the industry will exploit specialty applications, catering to those markets best serviced by LDPE, or will shut down.

In general, the West European market for both LDPE and LLDPE is expected to be highly competitive during the 1990's, arising from a continuing overcapacity for LDPE and substantial imports of LLDPE. In the early 1980's, the United States is expected to be a major source of these imports; however, in the mid-1980's and into the 1990's, the new and more cost-competitive plants in the Middle East will supply a growing proportion of West European imports.[36] These imports will be handled by U.S. companies such as Exxon and Mobil, which have ventures in the Middle East and are able to sell the product through their own European organizations.

Lack of West European competitiveness due to its feedstock position, small unit size, and age of facilities is expected to result in sizable LDPE shutdowns in the future. Established producers of LDPE in Western Europe will attempt to use their plants for specialty grades and in some cases will convert these grades to the production of LLDPE. Except for companies with access to North Sea gas, it will become increasingly difficult to compete with Middle Eastern general-purpose resin. These conditions, combined with market maturity and greater use of LLDPE, will result in rising net imports for Western Europe during a period of significant overcapacity.

Japan will eventually become a significant net importer of LLDPE, a change from its current position as a major exporter. Japanese producers will, however, maintain minimum exports of 100,000 to 125,000 tonnes per year of specialty grades while importing commodity grades such as LLDPE. Japan's loss of international competitiveness is being partially offset by Japanese offshore projects in Saudi Arabia and Singapore. Traders can be expected to market additional supplies of LLDPE from non-Japanese associated Middle East projects, in Japan as well as in traditional Japanese export markets in Asia.

While producers have expressed an interest in producing LLDPE, the Japanese Government has approved only three ventures, each of which involves the participation of more than one producer: Mitsubishi Petrochemical, Mitsui Petrochemical Industries, and Nippon Unicar. Other producers are evaluating the feasibility of retrofitting existing high- or low-pressure polyethylene capacity for the manufacture of LLDPE. Thus, both Western Europe and Japan will become net importers of LDPE/LLDPE while the United States will remain in net trade balance.

High-Density Polyethylene (HDPE)

Free world consumption of HDPE should increase from 5 million (1981) to nearly 10 million tonnes (1990), with the industrialized regions' share declining from 80 percent (1981) to approximately 75 percent (1990).

Although global growth rates of HDPE will be relatively high, growth in many developing countries will be uneven. Nevertheless, countries in Africa and the Pacific Basin may experience comparatively high growth in demand (more than 10 percent growth annually). Market growth in industrialized regions, particularly Western Europe and Japan, will be limited by slow economic growth, low population growth, market maturity, and competition from polypropylene.

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[35] Canadian imports are expected to rise, but from a net trade position, they are expected to be offset by equal amounts of U.S. exports to Latin America and elsewhere.

[36] This assumes that excessive tariffs or other protectionist measures are not instituted by the Europeans.

The global supply pattern for HDPE will change over the next few years with the greatest supply increases coming from: 1) Canada, which will become a major exporter to the Asia/Oceania markets; 2) Mexico and South America, which will add HDPE plant capacity to satisfy the projected strong increase in demand; 3) Eastern Europe, which will also add capacity to remain self-sufficient in HDPE; and 4) the Middle East, which will be a significant factor in global trade with its export-oriented projects.

Due to the increasing economic advantages enjoyed by producers with access to cheap ethane feedstock, the overall level of interregional trade in HDPE will grow, with the Middle East producers becoming important exporters, as shown in table 45. This increase in trade will be further facilitated by LLDPE producers, who will be able to produce HDPE with their spare LLDPE capacity. The major changes in trade shown in table 45 are based on the anticipated completion of a number of export-oriented plants in Canada and the Middle East. Japan will shift to a net import position by 1990 and both the United States and Western Europe should be able to maintain a reduced net export position. However, exports from Canada and the Middle East will be relatively limited and are not expected to offset exports from the United States or Western Europe. Japan and East Asia may be major target export markets for Middle Eastern HDPE.

Table 45.—World HDPE Trade (thousand metric tons)

	1980	1981	1985	1990
Western Europe	304	250	170	165
North America:				
United States	280	250	135	180
Canada	25	36	75	70
Japan	138	131	45	(120)
Pacific Basin	(176)	(180)	(109)	3
Latin America	(195)	(185)	(243)	(302)
Africa	(114)	(110)	(183)	(221)
Middle East	(80)	(87)	10	125
Other	20	20	100	100
Total	202	125	—	—

NOTE: Parentheses indicate net imports.

SOURCE: Office of Technology Assessment.

Blow molding, used to produce household chemical and food bottles, will continue to be the largest outlet for HDPE in the United States, accounting for about three-fourths of current demand. Table 43 shows the various product uses for HDPE. U.S. HDPE producers have a current production capacity of 2.7 million tonnes per year. New capacity is expected to be brought onstream during the mid-1980's to meet domestic requirements and incremental exports.

No significant restructuring of the U.S. HDPE industry as a result of Middle East or Canadian export projects is expected. However, LLDPE will influence HDPE production as a result of some market penetration and the ability of some LLDPE facilities to make a full range of polyethylene products—from LLDPE to HDPE.

In Western Europe no significant restructuring of this industry as a result of Middle East projects is expected. Unlike the United States and Western Europe, Japan is expected to move into a deficit position in HDPE by the later 1980's as a result of Middle Eastern and other projects. This is the result of Japan's conscious move to discontinue expansion of olefins projects, which will limit its position in HDPE as well. Nevertheless, Japan is expected to maintain an export position in specialty grades for film, fiber, and other extruded products. Imports will consist of molding and blow molding grades of resin.

Ethylene Glycol

By 1990 total consumption of ethylene glycol will probably have risen 50 percent from 1980, with the industrialized regions' share dropping from 83 to 75 percent in 1990 and to 70 percent by 2000. The relatively strong annual growth rate in demand in developing countries is driven by several factors; for example, continued strong growth in domestic polyester textile use in Southeast Asia, India, Latin America, and other developing areas, expansion of polyester apparel exports to the United States and Western Europe from the low labor-cost areas, particularly Southeast Asia, and increased use of ethylene glycol as an antifreeze/coolant while local demand and availability increases. In the industrialized regions, growth will be influenced by several opposing factors. These include slow growth in polyester fiber production, little or no growth in antifreeze use in Western Europe and the United States, and strong growth in polyester film and in PET resin for bottles.

The global supply picture for ethylene glycol will change substantially over the next decade. The most rapid increases in supply will be in the Middle East, which will become the largest regional exporter by far (see table 46). Canada, which has recently started one large export-oriented project and has another under development, and several countries of the Pacific Basin (India, Taiwan, Thailand, Indonesia) will also be important interregional exporters. As with LDPE, the increasing economic importance of access to less expensive ethane feedstocks will result in a substantial increase in the overall level of interregional trade in ethylene glycol. The major source of U.S. imports is expected to be Canada. Middle Eastern exports will dominate global trade patterns from the late 1980's onwards; additional projects are expected during the 1990's.

While the pricing of this material is not expected to be disruptive or destabilizing, the current world recession could cause rates of growth in demand to be below anticipated levels. The net effect of this could be large volumes of product with smaller markets than originally expected for the mid-1980's, and severe price competition erupting during the startup period for many projects. Tariffs currently in force will make Middle Eastern ethylene glycol economically unattractive in the United States. In Western Europe, tariffs are not currently in force, but have been discussed.[37]

Table 46.—Ethylene Glycol Net Interregional Trade (thousand metric tons)

	1981	1985	1990
Western Europe	100	30	(120)
North America:			
United States	75	83	(50)
Canada	94	195	220
Japan	(30)	(80)	(280)
Pacific Basin	(126)	(131)	33
Latin America	(13)	(23)	(96)
Africa	(34)	(42)	(42)
Middle East	(35)	(12)	360
Eastern Europe	(75)	(20)	(25)
Total	(44)	—	—

NOTE: Parentheses indicate net imports.

SOURCE: Office of Technology Assessment.

With the decontrol of natural gas prices in the United States, ethylene glycol costs will rise. However, imports may come primarily from Canada rather than the Middle East.[38] The major producers are committed to limited domestic expansion and recognize that strong international positions can only be maintained by countries having access to low-cost, gas-based feedstocks. With limited future capacity expansion likely, due to the loss of export markets and pricing strongly influenced by feedstock factors, plant shutdowns by the smaller, high-cost U.S. producers appear inevitable. The major producers have expressed little desire to invest in additional ethylene glycol capacity, preferring instead to upgrade available ethylene oxide (a precursor to ethylene glycol) to higher valued derivatives such as surfactants, glycol ethers, and ethanolamines. By 1990, therefore, it is likely that the United States will become a net importer of ethylene glycol.

Western Europe will also become a net importer of ethylene glycol. Any capacity additions are likely to be offset by shutdowns of small, old units. Material coming onstream in the Middle East, in combination with Canadian and East European capacity, will preclude Western Europe from export markets. Several West European producers are considering closing their glycol plants.

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[37] Susannah Tarbush, "Euro-Unions Tackle 'Threat' of Gulf Chemicals," *The Middle East*, September 1983, pp. 55-56.

[38] Union Carbide will import from Alberta, Canada, where it is constructing a new facility. Union Carbide dominates the U.S. ethylene glycol industry, with 40 percent of total installed capacity.

Japan will import material from offshore projects in which it is a participant and also from the international merchant market. With the import of ethylene glycol, the integrated ethylene oxide-glycol producers would be able to upgrade available ethylene oxide to higher valued derivatives, an option that would not necessitate additional investment in ethylene oxide-glycol facilities. Thus, it is anticipated that Japanese ethylene glycol producers will come through the petrochemical industry restructuring period intact because part of the reduction in Japanese ethylene glycol production will be compensated for by the growth in nonglycol markets for ethylene oxide, in which the Japanese producers will retain their strong position.

Styrene

In 1981, the industrialized regions of Western Europe, North America, and Japan accounted for over 89 percent of total styrene consumption. By 1990, total styrene consumption is expected to reach 10.5 million tonnes, of which the industrialized regions' share will decline to 82 percent. By the year 2000, the industrialized regions' share of global demand is expected to decrease further to approximately 75 percent.

The relatively strong growth in demand in the developing regions reflects the rapidly growing markets for appliances and other consumer durables in the more advanced countries such as Korea, Taiwan, the ASEAN countries, Mexico, and Brazil, growth of the electronics industry in the East Asian countries, and development of large markets for disposable products. In the industrialized regions, growth will be constrained by slow growth in consumer durables, production market maturity in disposable products (and some consumer/environmental reaction against them), mature synthetic rubber (SBR) markets, and increased competition for polystyrene from polypropylene.

The global supply picture for styrene will change substantially over the study period, with the most rapid increases in supply occurring in the Middle East, Canada, Latin America, the Pacific Basin, and the United States. The Middle East will become the largest regional net exporter by 1990, as shown in table 47, while Canada now has a strong export position and another export-oriented project under development. Latin America (Mexico and Brazil) and several countries of the Pacific Basin (India, Taiwan, Korea, and, ultimately, Indonesia) will produce the styrene required for their growing polystyrene and other derivatives industries. The United States, which will continue to be cost-competitive, will increase production to meet domestic demand and support continued exports.

Demand growth, coupled with benzene limitations,[39] will result in rapidly growing imports to Japan and other Pacific Basin countries and will result in a steady increase in the overall level of interregional trade in styrene. Japanese imports will grow substantially, owing to benzene supply limitations; Hong Kong will continue as a major importer; and Korea and Taiwan will ultimately become major importers. U.S. exports of styrene can be expected to decline but remain substantial. Canadian exports will grow with the completion of major export-oriented capacity, and Latin America will continue to import, despite production growth. Finally, Middle Eastern exports will become a major factor in global

Table 47.—Styrene Net Interregional Trade (thousand metric tons)

	1981	1985	1990
Western Europe	(100)	(100)	(100)
North America:			
United States	508	500	295
Canada	157	200	210
Japan	(161)	(250)	(390)
Pacific Basin	(187)	(136)	(246)
Latin America	(120)	(141)	(185)
Africa	(15)	(28)	—
Middle East	(5)	(12)	450
Eastern Europe	(50)	(30)	(30)
People's Republic of China	—	—	—
Total	27	3	4

NOTE: Parentheses indicate net imports.

SOURCE: Office of Technology Assessment.

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[39] The composition of styrene is approximately 70 percent benzene, a refinery product, and only approximately 30 percent ethylene. Lack of refining capability limits benzene supply and hence limits styrene production.

trade patterns from the late 1980's onwards, with most production flowing into Japan and East Asia.

Historically, the United States has been a major producer and exporter of styrene. Polystyrene accounted for 62 percent of total U.S. styrene consumption in 1981. Over 60 percent of the styrene produced in the United States is used for captive (within plant) purposes. Packaging and disposable items consume approximately one-half of the general-purpose and impact grades. Over the next decade, export shipments of styrene are not expected to decline as dramatically as those of other ethylene derivatives. U.S. producers are expected to maintain their export positions because of the availability of benzene from refinery and olefin operations that will be cost competitive with those in other areas of the world. There is adequate U.S. styrene capacity to last through the late 1980's. However, additional capacity will be required during the 1990's.

The relatively weak position of the West European styrene industry reflects a combination of very mature markets (i.e., polystyrene) and a weak raw material position. As such, net imports of styrene have been 100,000 to 150,000 tonnes per year for the past several years. These have come mainly from North America. This condition is expected to continue, with the source of imports switching in favor of the Middle East.

Japan's three largest styrene producers have capacities smaller than the large low-cost facilities in the United States. The combination of these scale factors and the feedstock costs in Japan relative to those in the United States minimizes the competitiveness of the Japanese styrene producers in the international market. Over the next few years, it is anticipated that the Japanese styrene industry will be restructured to reflect its changing situation. A number of small and energy inefficient units will be shut down, although some may be rebuilt into a unit having a higher capacity. New units will be at least 150,000 tonnes per year in size. In addition, Japan's imports of styrene are anticipated to grow substantially.[40]

Methanol

The United States, Western Europe, Eastern Europe, and Japan now account for approximately 90 percent of the global demand for methanol. This market share is expected to recede to approximately 75 percent by 2000.

Current global methanol demand is almost entirely for chemical applications. Growth in this area will be led by rapid growth in methanol demand for acetic acid manufacture because of the preferred economics of methanol carbonylations as compared to alternative techniques. Formaldehyde, by far the largest current market for methanol, will continue to grow in line with the demand for forest products, the most significant formaldehyde end-use market (see table 43). The rapidly growing methanol markets will be for fuel-related uses such as for MTBE (methyl tert-butyl ether), an effective gasoline octane booster. Direct blending with gasoline is a potentially large market, but this end-use will develop slowly, owing to concerns about performance as well as the short-term soft outlook for fuel products. These fuel-related uses may account for approximately one-quarter of total methanol demand by the year 2000.

In 1981, production in the United States, Western Europe, and Japan accounted for 63 percent of the global supply, reflecting the historical concentration of methanol capacity in industrialized nations. However, over 80 percent of the new methanol plants being built worldwide are outside the three major consuming regions. This is reflected in table 48, where major new suppliers are seen to be Canada, the Middle East region, and the ASEAN region. This highlights the economic advantage en-

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[40] Japanese styrene producers have pursued equity participation in offshore styrene projects, such as those in Canada, to obtain low-cost styrene or benzene to enhance either their domestic or export market position. See Takuya Araoka, "Petrochemical Industry Striving for Revitalization," *Journal of Japanese Trade and Industry*, No. 6, 1982, pp. 18-21.

Table 48.—Global Methanol Supply/Demand Balance (thousand metric tons)

	1981	1985	1990
North America:			
United States	300	155	(1,400)
Canada	200	1,370	1,440
Eastern Europe	100	600	800
Western Europe	(580)	(1,740)	(3,105)
Japan	(326)	(1,030)	(1,970)
ASEAN	(55)	723	1,225
Australia/New Zealand	(63)	230	320
Other Asian	(121)	(505)	(600)
Mexico	35	0	810
Central and South America	(75)	32	233
Middle East/Africa	345	1,200	2,065
Other	(80)	(128)	(200)
Total	(320)	907	(382)

NOTE: Due to timing uncertainties associated with the growth in fuel demand, no attempt was made to zero balance trade as was the case with other products in this study. Parentheses indicate net imports.

SOURCE: Office of Technology Assessment.

joyed by producers with access to larger supplies of relatively inexpensive gas. It is expected that Canada and Mexico will become major sources of U.S. methanol imports as well as significant competitors in East Asian markets. Western Europe and Japan will continue as the largest net importers of methanol. The Middle Eastern suppliers will become the largest net exporters of methanol worldwide.

The future of methanol has been fiercely debated in the chemical industry during recent years. Already the sixth largest industrial chemical in volume, methanol has been promoted as one of the leading candidates for a nonpetroleum-based fuel for a variety of applications. These markets are potentially many times the size of the chemical markets. Nevertheless, the U.S. industry is in an uncertain state since the recent global recession depressed the chemical demand for methanol. At the same time, while the current weak energy market is undermining the impetus for development of fuel-related applications of methanol, major export projects in Canada, the Middle East, Mexico, and Trinidad are in various stages of completion to take advantage of anticipated fuel markets.

The United States will gradually become a net importer of methanol. Additional domestic methanol capacity beyond that already announced will not likely be based on natural gas because of inadequate supplies. U.S. methanol producers are reluctant to commit themselves to alternate feedstocks such as coal-based plants because of the high capital costs and fear of competition from Canada and the Middle East, where relatively inexpensive natural gas is available. Unless more domestic capacity is planned beyond that currently foreseen, a major deficit in methanol supply could result by 1990. It is expected that substantial methanol imports will be utilized in advance of the construction of coal-based methanol plants in the 1990's, with the most likely sources being Canada, Mexico, Trinidad, and Saudi Arabia.

Western Europe, which is already a net importer, will continue to experience shutdowns in its methanol industry caused by lack of competitiveness with Middle Eastern and East European projects. New capacity will be limited and keyed to North Sea gas and possibly coal gasification in West Germany. Western Europe will face a rising deficit in methanol supply from regional sources and therefore will increase its dependence on imported methanol. Low-cost imports will likely lead to a situation in 1985 where European consumers rely on imports to meet 40 percent of demand.

Likewise, Japan will become an increasingly large net importer. Due to Japan's weak raw material position, it will be increasingly dependent on Canada, Saudi Arabia, New Zealand, and ASEAN nations as its primary sources of supply. Japan's methanol industry is not cost-competitive with methanol produced at these locations, which have natural gas costs that are substantially lower than those of Japan's current supply sources. Methanol production in Japan may eventually decline to about 400,000 tonnes per year.

Ammonia

Nitrogen fertilizer supply is increasing rapidly in the gas-rich developing countries,[41] while the developed countries are unable to justify new capacity additions because of high feedstock costs. This is a reversal in the historical pattern of world trade. The United States, Western Europe, and Japan will become (as a group) net importers of nitrogen fertilizers.

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[41] Demand will grow especially in highly populated developing countries including the Indian Subcontinent, Latin America, Africa, and China.

Historically, anhydrous ammonia has not been a major item of interregional trade, owing to its high shipping costs. However, a major long-distance international trade has developed, and can be expected to grow. Major importers will be the United States, Western Europe, and Japan. Three of the major exporters will be the Middle East, Mexico, and Canada (see table 49).

The United States consumes large quantities of ammonia primarily to support its role as a global exporter of foods and grains. Approximately 80 percent of all ammonia consumed in the United States is for fertilizer. Currently over 97 percent of U.S. ammonia capacity is based on natural gas feedstock. As U.S. natural gas becomes less abundant and more costly, the United States will continue to import large quantities of ammonia. Future coal gasification projects are expected to be insufficient to close this trade gap, and while some new capacity will be added it probably will not replace capacity lost to the closing of old units.

The most important suppliers of import nitrogen to the United States (mostly anhydrous ammonia) are currently Canada, Mexico, the U.S.S.R., and Trinidad/Tobago. The importance of these major sources of supply is expected to grow with little or no prospect for Middle Eastern exports to the United States. Imports of ammonia and urea from the U.S.S.R. will grow if the political climate is favorable. Since U.S. companies are closely involved in the Trinidad/Tobago operations, a large part of this production will enter the United States.

Table 49.—Anhydrous Ammonia Trade (thousand metric tons)

	1979-80	1984-85	1989-90
Asia/Orient	(43)	(814)	(1,186)
Indian Subcontinent	(100)	(200)	(500)
People's Republic of China	—	—	—
United States	(1,073)	(2,400)	(3,000)
Canada	400	450	550
Latin America	935	1,200	1,500
Middle East	70	680	1,010
Africa	—	320	440
Western Europe	(1,080)	(1,730)	(2,870)
Eastern Europe	1,400	2,540	4,060

NOTE: Parentheses indicate net imports.

SOURCE: Office of Technology Assessment.

The West European ammonia industry is strained. Escalating feedstock costs and continued pressure on ammonia and nitrogenous fertilizer prices are squeezing profit margins for the traditional producers in Western Europe. The forecasted global overcapacity and the concentration of competitive plants in the Middle East and Eastern Europe present a long-term threat to the West European countries. Many high-cost plants have already been closed, and more closures are expected. As imports grow, some producers and industry associations may seek government protection in the form of import quotas, tariffs, or subsidies. Pressure from the farming lobby for continued access to low-cost nutrients, plus external political and economic constraints, will limit such protection, provided total imports do not exceed levels considered strategically reasonable.

At present, ammonia and urea production in Japan are conducted under a cartel arrangement set up when Japanese firms lost their cost-competitiveness as a result of high feedstock prices.[42] Under this arrangement, ammonia and urea capacities were reduced, and a ban was placed on ammonia and urea imports until 1984. Despite this arrangement, the Japanese competitive position has deteriorated further.

Effects of Crude Oil Price Decreases

Currently, much uncertainty exists in world energy markets. Crude oil prices have declined, and supplies have generally grown in a manner unforeseen by governments, economists, or industry. This situation has simultaneously stimulated the economies of many nations and aggravated the debt position of others. In this environment, even those nations on the Persian Gulf with relatively small populations may be forced to delay some projects, withdraw foreign investments, or consider developing nonassociated gas for their hydrocarbon-based projects. The net effect of this would be decreased competitiveness with the United States in some markets, after allowance for freight to target markets. Moreover, these project delays are expected to have a delaying effect on second generation projects in the region.[43] The slower growth in crude oil prices has also reduced the petrochemical production costs of regions such as the United States, Japan, and Western Europe. Middle Eastern nations will at best have the same zero value for their raw materials, thus making them less competitive with these industrial regions.

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[42] Naptha accounts for 50 percent of the feedstock used for ammonia production in Japan.

The major industrial trading regions will benefit from the decline in crude oil prices. There will be an upward push on GDP and a downward pull on inflation. This may further stimulate GDP-related demand, which already benefits from the current economic recovery. In addition, synthetic (petrochemical-derived) materials, which have been competing with natural materials, will receive an added boost. This should be the pattern even for products having high energy costs. It reflects the nature of petrochemicals, which use energy products for fuel as well as for raw materials. Products using natural raw materials such as paper, however, can only take advantage of low crude oil prices in their fuel costs.

The recent effect of increased demand (due to GNP growth), delayed projects, and more competitive traditional petrochemical producers can be expected, in most instances, to result in firmer prices (in the West), a greater utilization of capacity already in place (healthier domestic industries), and a more gradual rationalization of the West European and Japanese petrochemical industries. As far as the United States is concerned, it will make it even less likely that Middle Eastern olefin derivatives will penetrate its shores. Moreover, the lower profitability profile expected for the Middle East argues against any attempts by these producers to penetrate U.S. markets by undercutting prices.

Olefins Derivatives.—The olefins derivatives examined here are polyethylene, ethylene glycol, and styrene. In each case, the impact of lower crude oil prices will be to increase consumption. Since the decline in crude oil costs will lessen the cost of petrochemical-derived products more than it will lessen the cost of naturally derived products, consumption of petrochemical-derived products will increase. Although this may not be reflected in mature markets such as those for bread wraps, it can be expected to help LLDPE penetrate the U.S. grocery (Kraft) bag market and the more GNP-sensitive applications, where increased consumer disposable income provides added impetus to demand. This latter category includes agricultural films (LDPE), tourist gift bags (LLDPE), and injection molded toys, and household, consumer, and industrial items (HDPE and styrene). In addition, from a national standpoint, lower crude oil prices will increase U.S. competitiveness in foreign markets.

Ethylene glycol is used primarily for polyester and automobile anti-freeze. Growth prospects for these applications will tend to reflect the simulative effect of lower crude oil prices on individual national economies. However, while polyester fiber may also benefit from increased cost competitiveness with cotton, fashion trends also tend to dictate the amounts of each consumed.

Styrene trade has been less affected by the drop in crude oil prices because only 22 percent of styrene is ethylene, the balance being benzene. Moreover, benzene prices in the Middle East tend to follow West European prices (any reduction in profitability would be shown in the refinery operations from which the benzene is produced). Nevertheless, the United States will benefit to some degree in styrene export markets, owing to its increased competitiveness (U.S.-manufactured benzene is competitive, and its ethylene will become more competitive). In addition, styrene consumption will improve because of the improved nature of the world economy. (This may be reflected in increased demand for styrenics in toys and appliances.)

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[43] As stated in Wharton (op. cit., April 1983, p. 78), "A sustained fall in oil prices toward $25/barrel is unlikely to have much effect on the generation of petrochemical plants already being constructed in the Middle East. Their economics may become marginally less attractive, but not enough to lead to any further significant cancellations. Where an oil price fall will have an effect is on the next generation of plants, which are still at the stage of initial discussion.

Methanol and Ammonia.—The impact of lower crude oil prices on methanol and ammonia will vary. While consumption will be favorably influenced by increased U.S. automobile usage and continuing demand for food worldwide, U.S. firms will continue to lose competitiveness in methanol and ammonia production, and significant imports can be expected in the future.

In the case of methanol, lower crude oil prices will result in more competitive U.S. facilities since the gap between U.S. costs and foreign competitors raw materials costs will not be as great (as in a $34/barrel market crude oil scenario). However, if marginal U.S. producers continue operations and lower crude oil prices result in a delay in the use of methanol in energy applications, the world oversupply would be further aggravated, pricing pressures would continue, and imports would still be expected. A delay in using methanol in gasoline blends, for example, could result simply from the availability of crude oil, a perception that energy alternatives are not necessary and, in those markets where methanol will be used as an octane enhancer rather than as a gasoline extender, increased competition from other materials (toluene).

In the case of ammonia, U.S. producers, with or without renegotiated natural gas contracts, can be expected to stay competitive longer. However, since there are fewer new ammonia projects coming onstream (as compared to methanol) and demand is large, the business environment is expected to be different than that for methanol. Nevertheless, the United States will import sizable quantities of ammonia during the 1980's.

IMPLICATIONS OF MIDDLE EAST PETROCHEMICAL INDUSTRY DEVELOPMENTS

IMPACTS ON RECIPIENT NATIONS

As petrochemical plants are built in the Middle East, a major effect has been rising demand for skilled manpower. These effects have been strongly felt in Saudi Arabia and Kuwait, where dependence on foreign manpower at all levels (but particularly in technical, professional, and managerial occupations) is high. These trends can be expected to continue for the foreseeable future.

The petrochemical industry has a broad occupational profile. The wide variety of jobs is partially due to the diverse range of products created in the industry, as well as to the industry's complexity. The high skill levels required in the industry indicate the need for extensive specialized training, for technicians, scientists and engineers, mechanics, and machine operatives. The occupational breakdown of this labor force may be approximated using the labor profile developed for the Middle East petrochemical industry by the United Nations Industrial Development Organization. Approximately 20 percent of these jobs will be technical or managerial.[44] All evidence indicates that in Saudi Arabia the great majority of these jobs, especially at the higher skill levels, will have to be staffed by nonnationals for several years into the future. In 1981, the

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[44] International Centre for Industrial Studies, *Draft World-Wide Study of the Petrochemical Industry* (Vienna: United Nations Industrial Development Organization, 1978).

Saudi labor force in the chemical, petroleum, and plastics sector numbered approximately 8,000. About 87 percent were non-Saudis.[45] A doubling in this work force may be required. Like Saudi Arabia, Kuwait will also rely very heavily, almost exclusively, on foreign workers if its expansion in petrochemicals proceeds.

Algeria, on the other hand, may need approximately 3,000 workers to satisfy its petrochemical program, most of whom are already in place. This would include about 600 professional and technical workers, 500 skilled workers, 900 operatives, and 500 clerical workers. With over 200,000 professional and technical workers in the Algerian labor force, and around 2,000 new university graduates per year in science and technology fields, the requirement of a few hundred additional technical workers should not present a problem to their petrochemical sector. Similarly, Egypt will probably be able to meet its manpower needs. The only possible problem area could be in the managerial positions, owing to limited previous labor force experience with petrochemical production. The major manpower difficulty in Egypt would thus be the quality of labor and its productivity.

In contrast, both Iraq and Iran had substantial petrochemical manpower forces prior to the Iran-Iraq War. The Iraqi labor force in petrochemicals was estimated at over 17,000 workers in 1977. Iran also had a large trained cadre of petrochemical workers operating about 10 petrochemical plants. The ongoing war between Iran and Iraq and the unknown damage to their petrochemical plants make future manpower supply or needs impossible to predict for these two countries.

IMPLICATIONS FOR U.S. POLICY

A gradual erosion in the competitiveness of U.S. petrochemical producers can be expected because of feedstock advantages in other regions of the world, among other factors. The impending decontrol of natural gas prices will make U.S. commodity petrochemicals less competitive on world markets and may further increase imports of ammonia into the United States. The U.S. petrochemical industry may, however, remain strong, owing to large domestic demand, increasingly efficient operations, and R&D efforts. The industry's major loss will be in exports. No major loss of U.S. jobs in the petrochemical sector is anticipated. U.S. contractors and licensors have had a strong presence in the Middle East and projects there yield revenues to the United States through taxes and income. U.S. producers will, however, be challenged to adjust their production and strategies in order to respond to anticipated changes in the world petrochemical market.

No cases were identified where contracts were lost because of the Foreign Corrupt Practices Act or antiboycott legislation, and recent changes in the tax laws concerning income tax on U.S. citizens' foreign earnings have reduced this as a disadvantage to U.S. firms. Export financing has been a less significant factor in contract awards in this sector than in some others examined by OTA, due to the fact that the Gulf States (Saudi Arabia in particular) have been in a position to provide attractive financing terms to foreign investors.

A major concern for U.S. policymakers will be with potential protectionist measures abroad. U.S. tariffs on petrochemicals after the Tokyo round of tariff reductions are not generally judged excessive, but countries in the Middle East want more favorable tariff treatment. Restructuring of the U.S. petrochemical industry is occurring, as in Japan. In Western Europe, however, the admittedly necessary restructuring is progressing slowly, as political pressures make plant closures or "rationalization" difficult.[46] In 1983 in the

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[45] Kingdom of Saudi Arabia, *Census of Primary Establishments*, 1981, cites a total figure of 8,196 workers in these categories. See also Federal Democratic Republic of Algeria, ASIDC, UNIDO, *Status of Arab Industry and Future Concept for Arab Industrial Development Up to the Year 2000*, 1979, which gives a figure of 6,400 workers in the chemical industry for 1973.

[46] A Working Group's Report to the European Economic Commission, "Restructuring the West European Petrochemical Industry," ("Gatti-Grenier Report"), May 1983. In this report, the following reductions in West European petrochemical capacity were recommended: ethylene 20% (from 15 to 12 million tons/year), LDPE 24.5% (from 5.3 to 4.0 mt/yr), and HDPE

European Economic Community, capacity utilization remained below 60 percent on average, despite a beginning upturn in production worldwide.[47] If protectionist measures are imposed by the West Europeans, more product than anticipated could end up flowing to the United States, at best; at worst, severe commodity chemical price cuts could occur. Table 50 shows tariff rates on petrochemicals imported to the United States, Japan, and Western Europe.

The Middle East producers aspire to be accepted as major players in worldwide petrochemical trade. If the need arises, however, they have the wherewithal (owing to inexpensive feedstocks, surplus capital, and state-of-the-art facilities) to force their entry.[48] In the long run, however, price cutting would be detrimental to all producers. In response, the Europeans will be reluctant to take a purely protectionist stand against the new petrochemical exporters, because this would be a diplomatic embarrassment to the ECC.[49] On the other hand, protectionist advocacy has been evident in West Europe, directed against the Japanese and the newly industrializing countries, such as Hong Kong, South Korea, and Taiwan. Perhaps the greatest contribution the United States can make is to encourage multilateral agreements so that the new petrochemical producers of the Middle East and other regions, whose entry into world markets is certain, will cause as little disruption as possible.

Thus, U.S. policy options are limited. Measures which encourage U.S. firms to adjust to the anticipated worldwide restructuring of the petrochemical industry could be a contribution. The traditional stress on R&D characteristic of the industry must be maintained so that U.S. firms can specialize in the development of higher valued-added fine chemicals, produced through more efficient processes. Opportunities for the U.S. industry lie in operations further downstream. Rather than sector-specific policies, those that promote the development of technical manpower in the United States, and those that encourage R&D across a broad spectrum of industries should contribute to readjustment.

CONCLUSION

A major shift is occurring in the worldwide petrochemical industry. The Middle East (as well as Canada, Mexico, and Southeast Asia) will become more important as a source of petrochemicals in the near to midterm. Canadian and Middle Eastern developments will have the most significant impact on global trade in the mid and late 1990's. Middle Eastern producers, such as Saudi Arabia, want to be world-scale producers of petrochemicals and have the means to do it. Generally speaking, they intend to prevent large disruptions in petrochemical markets, but they hope to reach their goals.

Firms in western Canada and Mexico are more likely to make significant inroads into the U.S. petrochemical market than Middle East manufacturers. In any case, U.S. petrochemicals will remain generally strong despite the fact that the United States will become a net importer of ethylene glycol and methanol by 1990 (mostly from Canada). The United

Table 50.—Petrochemical Tariffs (percent)

Product	Western Europe[a]	United States	Japan[a]
Polyethylene	14.7	13.4	6.2
Ethylene glycol	15.1	13.1	12.0
Styrene monomer	6.3	9.0+ 0.7¢/lb	8.0
Methanol	13.7	18.6	5.3
Ammonia	11.1	—	3.8

[a] Middle Eastern imports are currently duty free. However, as Middle Eastern exports increase in volume, they may be subject to the same tariff rates used by the United States.

SOURCE: Office of Technology Assessment.

24% (from 2.5 to 1.9 mt/yr). See also Paul Cheeseright and Carla Rapoport, "European Groups Fail to Agree on Chemicals Cuts," *Financial Times*, June 1, 1983, p. 1.

[47] See Commission of the European Communities, *European Economy*, Supplement B, No. 11, November 1983, pp. 4-5; "Facts and Figures for the Chemical Industry," *Chemical and Engineering News*, June 13, 1983, p. 26.

[48] "Saudi Counter-Measures if Europeans Impose Protectionism," reported in JPRS, Near East/South Asia, Oct. 12, 1983, from *Al-Mustaqbal*, in Arabic, No. 333, July 9, 1983, pp. 51-52. See also "SABIC Warns Against Protectionism," *Middle East Economic Digest*, Aug. 12, 1983, p. 45, and "Petrochemical Producers Urged to Cooperate," *Middle East Economic Digest*, November 11, 1983.

[49] Wharton, op. cit., pp. 66-67.

States is already a net importer of ammonia. However, U.S. specialty chemicals may actually gain strength, and employment effects should be minimal because U.S. producers can be expected to continue to supply the domestic market in many product areas.

The effects of the growth of petrochemical production in the Middle East may be more severe in Western Europe and Japan. Western Europe must continue to rationalize its petrochemical industry, but this will be a painful process. Japan has already realized that it cannot compete against low-cost feedstocks and is bowing out of direct production. Japanese firms are participating in development of the Middle East petrochemical industry because this is viewed as in the national interest, among other reasons.

Manpower and maintenance will be the key problems for Middle Eastern petrochemical producers. However, for many of these countries petrochemical production is an appropriate technology. As a result of their aim to become world-class exporters of petrochemicals, Middle East manufacturers will remain strongly dependent on foreign expertise until the turn of the century. By working with foreigners and obtaining technology developed abroad, they should be able to achieve these goals.

Technology transfers to the Middle East will contribute to the growth of a major petrochemical export industry there. While it appears that U.S. producers will remain significant in most product areas, their exports will diminish as the new plants now under construction in the Middle East and elsewhere come on line. Because petrochemical production technology has become fairly standardized (with the exception of some catalysts), no one nation can maintain a position of clear leader as a supplier across the board. Technology transfer to Middle Eastern and other developing countries will increase regardless of the strategies adopted by specific U.S. firms.

From the perspective of U.S. policymakers, policy options to offset these trends are fairly limited. On the one hand, efforts to negotiate multinational agreements supporting free trade may help to stave off a protectionist backlash in Europe which could result in increased flows of product to the United States. On the other hand, policies designed to encourage R&D and expansion of the technical manpower pool may ease adjustment in the U.S. petrochemical industry as in other industries facing global trade restructuring.

APPENDIX 5A: PETROCHEMICAL PRODUCT USES[1]

At the heart of the petrochemical industry are key chemical "building blocks" (e.g., ethylene) that can be derived from the processing of natural gases or from byproducts of the oil refining process. Some building blocks can be produced from either source.

Oil refineries produce a range of products including naphtha and gas oil which can be treated in plants known as crackers to produce building blocks such as ethylene, propylene, or butadiene (generically, these are called olefins). Naphtha can also be processed in a reformer to produce the major aromatic building blocks, benzene, toluene, and the xylenes. These building blocks can then be processed further to produce derivative products ranging from explosives to plastic films.

The problem with the refinery-based approach is that the more gasoline needed from a refinery, the less naphtha is produced; this, in turn, forces petrochemical producers to build expensive steam crackers to convert more difficult refinery byproducts, such as gas oil, into the desired building blocks.

In the case of olefins, it is possible to take the alternative route of using natural gas. Natural gas can be broken down into the simplest carbon molecules, C_1 (methane), C_2 (ethane), C_3 (propane), and C_4 (butane). Methane can be further processed into products such as ammonia or methanol. The other three feedstocks can be turned into varying proportions of the olefin building blocks. (By weight, ethane yields 80 percent ethylene, while butane yields proportionally less ethylene and more propylene.)

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[1] Based on the appendix of Louis Turner and James M. Bedore, *Middle East Industrialization—A Study of Saudi and Iranian Downstream Investment*, Saxon House, 1980, pp. 203-206. Also see Dale F. Rudd, *Petrochemical Technology Assessment* (New York: Wylie Interscience, 1981).

Figure 5A-1 gives a simplified illustration of the various ways the basic building blocks of the petrochemical industry can be produced. It clearly shows that there is considerable flexibility in producing olefins. Much of the controversy about the comparative economics of producing these in the Middle East or in the industrialized world rests on the fact that one can start with either gas or crude oil. Typical end-uses of derivative chemicals produced from the main building blocks are:

1. **Outlets for ethylene derivatives:**
   - Polyethylene—films, moldings, pipes, cable covering, netting, etc.
   - Ethylene oxide—intermediate product in chain leading to antifreeze, polyester fibers (terylene) and detergents.
   - Styrene—polystyrene plastics and synthetic fibers.
   - Ethylene dichloride—step towards polyvinyl chloride (PVC) plastics, used for leathercloth, piping, guttering.
   - Other derivatives—ethyl alcohol and acetaldehyde.
2. **Outlets for propylene derivatives:**
   - Polypropylene—films, fibers, and plastic moldings.
   - Cumene—intermediate products for plastics, nylon, and solvents.
   - Acrylonitrile—base for acrylic fibers; used in chain leading to nylon.
   - Propylene oxide—intermediate for manufacture of plastic foam.
   - Other products are involved in detergent and resin manufacture.
3. **Outlets for butadiene and other C_4 olefins:**
   - Butadiene's derivatives are heavily used in synthetic rubber production.
   - Other end-uses of butadiene and the other C_4 olefins include solvents, sealing compounds and the raw material for nylon.
4. **Outlets for aromatic derivatives:**

   Benzene—
   - Styrene (also from ethylene)—polystyrene plastics and synthetic rubber.
   - Phenol—intermediate for resins.
   - Cyclohexane—intermediate for nylon production.
   - Other products are used for detergents, dyestuffs and polyester glass-fiber plastics.

   Toluene—
   - Derivatives used for plastic foams, resins, explosives (TNT), and paints.

   Xylenes—
   - Derivatives used for paints, lacquers, insecticides, polyester fibers, and resins.

SPECIALTY CHEMICALS

Specialty chemicals can be defined as small volume products, with a variable composition, that are sold to a performance specification. Examples include antioxidants and oil field chemicals. These types of chemicals have higher value added, and hence profit, than commodity chemicals for those companies that can produce them.[2] They are also generally identified by brand name and are often produced by proprietary processes. Due to competitive pressure facing commodity chemicals manufacturers from rising raw material costs, slower than expected growth in demand, and increasing competition from new export-oriented petrochemical plants, specialty chemicals have received renewed interest.

Specialty chemicals cannot, however, by themselves be the salvation of petrochemical companies forced out of the commodity chemical business due to competition. The changing environment of the petrochemical industry encourages a move toward the higher margins afforded by some specialty chemicals. In order to realize these margins in practice, however, there must be careful selection and promotion, and increased R&D funds generally are required.[3] In addition, it must be recognized that the cash flow associated with specialties will be small in comparison to commodities. If production of the specialty begins to reach substantial quantities, new producers can be expected to enter the market. Thus these low-volume, high value-added specialty chemicals are unlikely to be a complete answer to petrochemical industry problems, but if carefully selected can be a welcome addition to the companies' operations.

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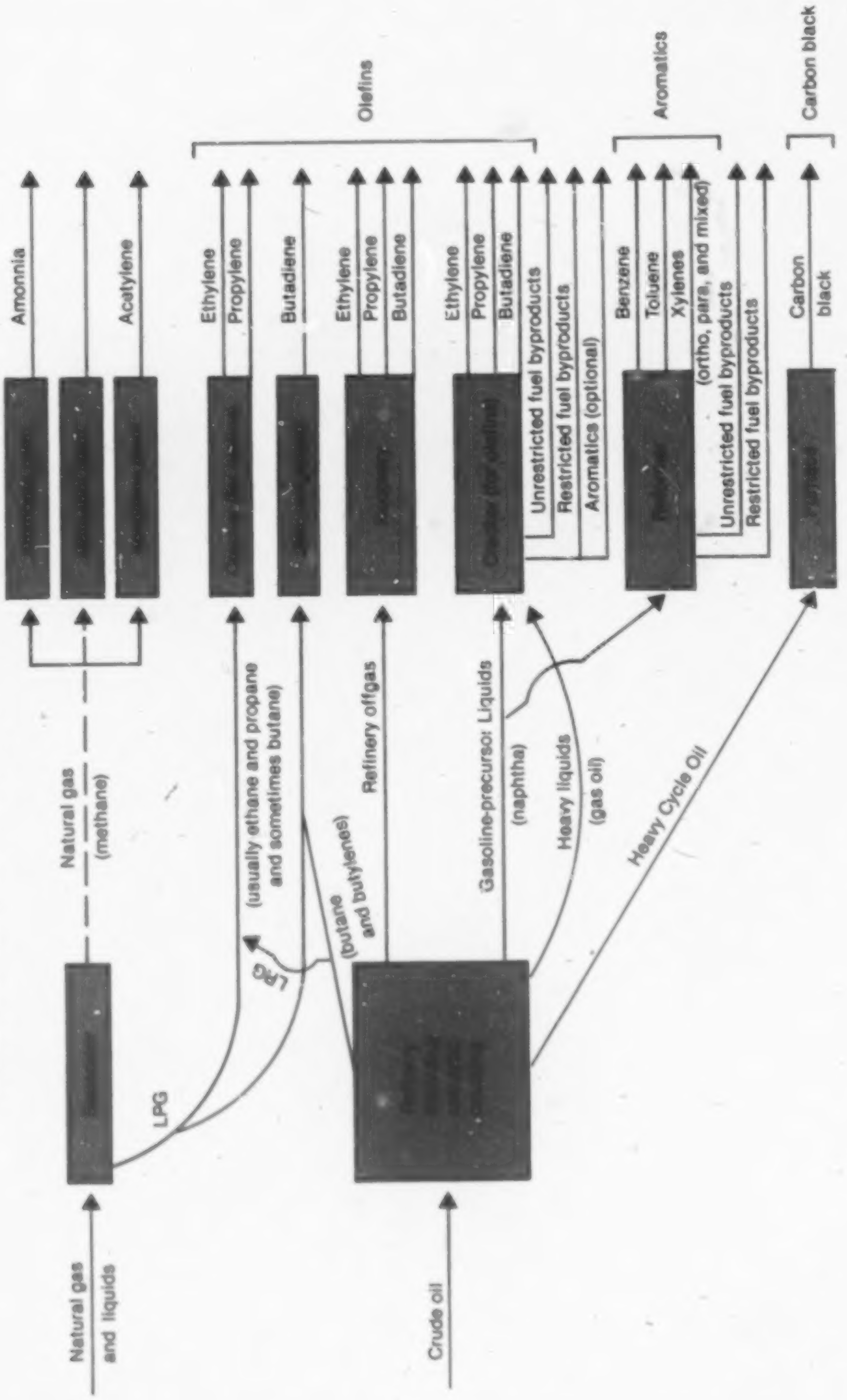
[2] See for example: Larry D. Rosenberg and Charles H. Kline, "Seeking Profits Downstream: The Lure of Specialty and Fine Chemicals," *Platts Petrochemical Conference*, Lausanne, Switzerland, May 12, 1981; and Peter B. Godfrey, "Specialty and Fine Chemicals: A Panacea for Profits?" *The Outlook for Petrochemicals—Profiting in a Troubled World*, paper presented at a conference held by the Energy Bureau, Inc., Nov. 30—Dec. 1, 1982, Houston, Tex.

[3] "Specialties Pose Problems, Challenges for Chemical Firms," *Chemical and Engineering News*, Apr. 23, 1984, pp. 8-9.

Figure 5A-1.—Simplified Flow Diagram of Primary Petrochemical Production



APPENDIX 5B: PETROCHEMICAL PROJECT PROFILES

Table 5B-1.—Saudi Arabia—Mobil Joint Venture

Venture name:	Saudi Yanbu Petrochemical Co. (Yanpet)	
Products:	Ethylene; LLDPE; HDPE; ethylene glycol (EG)	
Capacity:	Ethylene—455,000 metric tons LLDPE—205,000 metric tons HDPE—90,000 metric tons EG—220,000 metric tons	
Location:	Yanbu	
JV partners:	SABIC 50%; Mobil 50%	
Financing:	Debt: 60% Saudi loan (preferred rates)	$1,200 million
	10% commercial loan (standard rates)	200
	Equity: 15% Saudi	300
	15% Mobil	300
	Total	$2,000 million
Structure:	• Standard Saudi Arabian agreement • Based on this project and the refinery project, Mobil will receive an estimated 1.4 billion barrels of crude over 15 years • Mobil is committed to market approximately 75 percent of products produced, while SABIC can market up to 25 percent. In the initial years Mobil is likely to market nearly all material produced • Mobil is responsible for technical, marketing, and management training	
Project initiation:	1980. First study was conducted in 1976 with Mobil and Bechtel. The estimated value at that time was $817 million for the project. The study cost an estimated $10 million	
Project startup:	1985	
Major contracts:	Bechtel—Project management, construction, procurement. Also process engineering for LLDPE/HDPE Lummus—Design and engineering of ethylene facility and process license. Will also develop process simulators for training Union Carbide Corp.—LLDPE/HDPE license Scientific Design (SD)—EG license Halcon (SD subsidiary)—Process engineering of EG facility Belleli (Italy)—Construction of modular units under Bechtel contract	
Target markets:	Japan, Southeast Asia, Western Europe, Africa, and miscellaneous other. Limited exports to the United States are possible in the late 1980's	

SOURCE: Office of Technology Assessment.

Table 5B-2.—Saudi Arabia—Exxon Joint Venture

Venture name:	Al-Jubail Petrochemical Co. (Kemya)	
Product:	Linear low-density polyethylene	
Capacity:	260,000 metric tons	
Location:	Al-Jubail	
JV partners:	SABIC 50%; Exxon 50%	
Financing:	Debt: 60% Saudi loan (preferred rates)	$ 780 million
	10% commercial loan (standard rates)	130
	Equity: 15% Saudi	195
	15% Exxon	195
	Total	$1,300 million
Structure:	• Standard Saudi Arabian agreement	
	• Exxon's crude entitlement is 405 million barrels over a 19-year period	
	• Ethylene is received from Shell JV (Saudi P/C—SADAF). Total volume is approximately 260,000 metric tons	
	• To avoid paying an ethylene transfer price to SADAF, Exxon payed for approximately 38 percent of the cost of the olefins cracker and support facilities. Since Exxon does not own a percentage of the facility, it is equivalent to paying for ethylene in advance. Once the facility comes onstream, Exxon will pay for its proportionate share of operating costs. The rationale for this structure was the difficulty in finding a suitable benchmark mechanism for establishing an ethylene transfer price in Saudi Arabia	
	• Exxon is responsible for all export sales, except for the surrounding region. SABIC would like to eventually assume the responsibility for 50 percent of all sales	
	• Exxon is responsible for the technical and market training program	
Project initiation:	1980. Preliminary study and discussions in 1977	
Project startup:	Contingent on Shell startup, approximately 1985-86	
Major contracts:	Fluor—Project management, construction and procurement	
	Union Carbide Corp.—LLDPE/HDPE license	
	Daewdo Shipbuilding (South Korea)—Modules, under Fluor contract	
Target markets:	East Asia, Western Europe, Africa, and miscellaneous other	

SOURCE: Office of Technology Assessment.

Table 5B-3.—Saudi Arabia—Mitsubishi Joint Venture

Venture name:	Saudi Methanol Co. (SAMCO)
Product:	Methanol
Capacity:	600,000 metric tons
Location:	Al-Jubail
JV partners:	SABIC 50%; Japanese Consortium (JSAMC)—50%
JSAMC partners:	Mitsubishi Gas Chemical—40% of JSAMC Japan Overseas Economic Cooperation Fund—40% of JSAMC Sumitomo Chemical—5% of JSAMC Mitsui Toatsu—5% of JSAMC Kyowa Gas, Chemical—5% of JSAMC C. Itoh—5% of JSAMC
Financing:	Debt: 60% Saudi loan (preferred rates) .... $161 million 10% commercial loan (standard rates) .... 27 Equity: 15% Saudi .... 40 15% JSAMC .... 40 Total .... $268 million The total cost of this project when completed in 1983 was estimated to be $500 million
Structure:	• Standard Saudi Arabian agreement • Japanese Government uses the Overseas Economic Cooperation Fund (OECF) to support the joint venture. OECF's $14 million project loan was instrumental in securing this venture as well as additional oil supplies. The exact amount of crude entitlement is not known but is estimated at approximately 20 million barrels per day over a 15-year period
Project initiation:	1979
Project startup:	1983
Major contracts:	Chem Systems—Advisors to SABIC on project definition and process design Mitsubishi Heavy Industries—Project management, construction (built modules in Japan) and procurement Mitsubishi Gas Chemicals—Process license, design, and engineering
Target markets:	Japan, East Asia, and miscellaneous other

SOURCE: Office of Technology Assessment.

Table 5B-4.—Kuwait Petrochemical Project

Venture name:	PIC Petrochemicals
Products:	Olefins and derivatives; possibility of aromatics derivatives
Capacity:	Products under consideration are: •Primary products: •—Ethylene—350,000 metric tons per year —LLDPE—165,000 metric tons per year —Ethylene glycol—135,000 metric tons per year —Styrene—340,000 metric tons per year —Benzene—280,000 metric tons per year (for styrene production) •Secondary (speculative) products: —o-Xylene—60,000 metric tons per year —p-Xylene—90,000 metric tons per year
Location:	Shuaiba
JV partners:	None intended at present, earlier proposals included BASF (LDPE) and W. R. Grace (aromatics). Hoechst would be a logical choice
Financing:	Would likely be internally financed. Total value $1.3 billion
Structure:	Intended ownership (100 percent) Petrochemical Industries Co. KSC (PIC), a wholly owned subsidiary of Kuwait Petroleum Co. (KPC). The latter is a state-owned holding company
Project initiation:	Feasibility study for olefins and derivatives undertaken in 1976-77 by Chem Systems
Project startup:	Not yet fully committed. Likely start up in late 1980's
Major contracts:	Chem Systems—Feasibility study, 1976; market study, 1982 C. F. Braun[a]—Preliminary engineering 1981-82
Target markets:	East Asia, Western Europe, and miscellaneous other. Potential exports to the United States

[a] C. F. Braun is controlled by KPC, being a subsidiary of Santa Fe Corp., recently acquired by KPC.

SOURCE: Office of Technology Assessment.

Table 5B-5.—Qatar—CdF Chimie Joint Venture

Venture name:	Qatar Petrochemical Co. (QAPCO)	
Product:	Ethylene/LDPE	
Capacity:	Ethylene—280,000 metric tons LDPE—150,000 metric tons	
Location:	Umm Said	
JV partners:	CdF Chimie—16%; QGCP—84%	
Financing:	Total value $600 million. Exact structure or payments by CdF not known due to complexity of associated agreements. However, general structure is an 85/15 debt/equity arrangement. Euroloans were once associated with the project, but later assumed by Qatar	
	Debt: 50% French credits (@ 8.25%)	$300 million
	35% Qatar loans (preferred rates)	210
	Equity: 13% Qatar	76
	2% CdF Chimie	14
	Total	$600 million
Structure:	• Project was conceived as a back-to-back deal following 60-40 JV with CdF Chimie and Qatar in Dunkirk, France. Capacity at Dunkirk is 225,000 metric tons ethylene and 150,000 metric tons LDPE. The JV was French-Government promoted to foster "French Arab Cooperation" and the recycling of petrodollars. The Dunkirk startup was in 1978 • CdF will manage Qatar facilities and be responsible for marketing. Revenues will be earned on a commission basis. Sales offices have been set up in Hong Kong, Singapore, and Bangkok	
Project initiation:	1977	
Project startup:	1980	
Major contracts:	Chem Systems—Prefeasibility of Qatar Project; Assessment of Dunkirk Facility Technip (France)—Construction of ethylene cracker Coppee Rust (Belgium)—Construction of LDPE plant (stamicarbon process) Turbotechnica—Supply to 50-MW power station CdF Chimie—Supply LDPE technology and overall project responsibility	
Target markets:	Middle East and Southeast Asia	

SOURCE: Office of Technology Assessment.

Table 5B-6.—Bahrain

Venture name:	Gulf Petrochemical Co. (GPCO)	
Product:	Methanol/ammonia	
Capacity:	Methanol—270,000 metric tons per year Ammonia—270,000 metric tons per year	
Location:	Sitra island (artificial island)	
JV partners:	BANOCO (Bahrain National Oil Co.)/PIC/SABIC—equal ownership	
Financing:	Debt: Arab Consortium (85%; soft terms)	$300 million
	Equity: (15%)	50
	Total	$350 million
Project initiation:	1980-81	
Project startup:	1984-85	
Major contracts:	Snamprogetti—Engineering services and construction, detailed engineering, equipment procurement, construction Uhde—Responsible for licensing ammonia technology and Uhde/ICI methanol technology King Wilkinson—Engineering and construction advisors Wimpy Labs (UK)—Site survey and sales analysis Cowiconsult (UK)—Project site consultants	
Target markets:	China and Southeast Asia	

SOURCE: Office of Technology Assessment.

Table 5B-7.—Algeria—Sonatrach Ammonia (Arzew)

Venture name:	Sonatrach
Product:	Ammonia
Capacity:	272,000 metric tons
Location:	Arzew
JV partners:	None
Financing:	International commercial rate; total value estimated at $150 million as compared to the 1976 estimate of approximately $100 million to $115 million
Project initiation:	1976
Project startup:	1981
Major contracts:	Creusôt-Loire (CLE)—Project management, installation Pullman Kellogg—Design, engineering, and training prior to startup; operating and training contract since startup Chem Systems—Technical advisors through 1978
Target markets:	Domestic consumption and incremental exports

SOURCE: Office of Technology Assessment.

Table 5B-8.—Algeria—Sonatrach LNG #2 (Arzew)

Venture name:	Sonatrach	
Capacity:	1 billion scfd of gas	
Location:	Arzew	
JV partners:	None	
Financing:	Local commercial financing	$ 300 million
	Foreign government financing:	
	Canada	125
	U.S. Ex-Im Bank	350
	Japanese Government financing	350
	Belgium/Holland financing	100
	Total	$1,225 million
Structure:	Foreign government loans tend to be tied to procurement from those nations. The United States does not maintain this type of policy. However, the United States requires 50% of the value of its loan shipped on U.S. flag ships	
Project initiation:	1976	
Project startup:	1981	
Major contracts:	Kellogg—Project management, design/engineering, and construction	
Target markets:	United States and Western Europe	

SOURCE: Office of Technology Assessment.

APPENDIX 5C: PETROCHEMICAL PRODUCT DEMAND PROJECTION

Table 5C-1.—Free World LDPE Demand (thousand metric tons)

	1981	1985	1990	Compound annual growth rate, % 1981-90
Western Europe	3,450	3,930	4,330	2.6
North America:				
United States	2,985	3,930	4,985	5.9
Canada	345	450	575	5.8
Japan	920	1,170	1,440	5.1
Pacific Basin and Indian Subcontinent	721	1,083	1,537	8.8
Latin America	850	1,165	1,768	8.6
Africa	304	397	563	7.1
Middle East	229	300	418	6.9
Total	9,804	12,425	15,616	5.3 (average)

SOURCE: Office of Technology Assessment.

Table 5C-2.—Canadian and Middle Eastern LDPE/LLDPE Export Mix, 1990 (percent)

	Middle East	Canada
United States	N	N
Western Europe	10-15	—
Japan/East Asia	45	60
Other	38-40	40
Total	100	100

N = negligible.

SOURCE: Office of Technology Assessment.

Table 5C-3.—U.S. Demand for LDPE/LLDPE (thousand metric tons)

	1980	1981	1985	1990	Compound annual growth rate, % 1981-90
Film and sheet	1,824	1,856	2,365	2,996	4.9
Injection molding	235	238	390	490	6.2
Extrusion molding	235	256	270	280	1.0
Wire and cable	152	157	235	295	5.7
Other	414	478	670	925	6.3
Total	2,860	2,985	3,930	4,985	5.1 (average)

SOURCE: Office of Technology Assessment.

Table 5C-4.—Free World HDPE Demand (thousand metric tons)

	1980	1981	1985	1990	Compound annual growth rate, % 1980-90
Western Europe	1,424	1,450	1,700	2,000	3.6
North America:					
United States	1,720	1,880	2,960	4,165	9.2
Canada	177	186	270	390	8.6
Japan	543	507	755	920	6.8
Pacific Basin	392	384	648	994	11.1
Latin America	383	374	578	872	9.9
Africa	169	165	258	431	11.3
Middle East	80	87	135	180	8.4
Total	4,888	5,033	7,304	9,952	7.9

SOURCE: Office of Technology Assessment.

Table 5C-5.—U.S. High-Density Polyethylene Demand (thousand metric tons)

	1980	1981	1985	1990	Compound annual growth rate, % 1981-90
Blow molding	733	781	1,175	1,645	8.6
Injection molding	425	457	685	885	7.6
Pipe and conduit	175	194	355	465	10.2
Film and sheet	136	170	280	530	13.5
Wire and cable	48	50	80	115	9.7
Other	201	227	385	525	9.8
Domestic demand	1,718	1,879	2,960	4,165	9.3 (average)

SOURCE: Office of Technology Assessment.

Table 5C-6.—Free World Ethylene Glycol Demand (thousand metric tons)

	1981	1985	1990	Compound annual growth rate, % 1981-90
Western Europe	690	735	805	1.7
North America:				
United States	1,779	2,075	2,545	4.1
Canada	136	143	165	2.2
Japan	400	495	575	4.1
Pacific Basin	370	517	720	7.7
Latin America	164	258	381	9.8
Africa	34	72	127	15.8
Middle East	35	62	94	11.6
Total	3,608	4,357	5,412	4.6 (average)

SOURCE: Office of Technology Assessment.

Table 5C-7.—Projected Canadian and Middle Eastern Export Mix, 1990 (percent)

	Middle East	Canada
United States	N	23
West European	33	—
Japan/East Asia	45	45
Other	22	32
Total	100	100

N = negligible.

SOURCE: Office of Technology Assessment.

Table 5C-8.—United States Ethylene Glycol Demand (thousand metric tons)

	1980	1981	1985	1990	Compound annual growth rate, % 1981-90
Antifreeze	769	733	800	895	2.2
Polyester fibers	760	796	905	1,075	3.4
Polyester film	67	65	90	130	8.0
PET bottle resins	58	68	140	260	16.1
Other	122	116	140	185	5.3
Total	1,776	1,778	2,075	2,545	4.1 (average)

SOURCE: Office of Technology Assessment.

Table 5C-9.—Free World Styrene Demand (thousand metric tons)

	1981	1985	1990	Compound annual growth rate, % 1981-90
Western Europe	2,500	2,600	2,700	0.9
North America:				
United States	2,647	3,175	3,830	4.2
Canada	219	280	360	5.7
Japan	1,256	1,495	1,785	4.0
Pacific Basin	413	615	858	8.5
Latin America	384	606	880	9.7
Africa	34	47	70	8.4
Middle East	23	30	35	4.8
Total	7,476	8,848	10,518	3.9 (average)

SOURCE: Office of Technology Assessment.

Table 5C-10.—Projected Middle Eastern and Canadian Styrene Export Mix (percent)

	Middle East	Canada	United States
United States	—	—	—
Europe	30	—	—
Japan/East Asia	60	100	50
Other	10	—	50

SOURCE: Office of Technology Assessment.

Table 5C-11.—U.S. Demand for Styrene (thousand metric tons)

	1980	1981	1985	1990	Compound annual growth rate, % 1981-90
Polystyrene	1,595	1,633	1,970	2,320	4.0
SBR/SBR latex	254	238	265	290	2.2
ABS resins	238	234	285	375	5.4
SB latex	168	177	215	255	4.1
Polyesters	150	169	205	285	6.0
SAN resins	37	38	45	50	3.1
Other	152	158	190	255	5.5
Total	2,594	2,647	3,175	3,830	4.2 (average)

SOURCE: Office of Technology Assessment.

Table 5C-12.—Global Methanol Demand (thousand metric tons)

	1981	1985	1990	Compound annual growth rate, % 1981-90
North America:				
United States	3,510	5,025	7,170	8.3
Canada	240	290	580	10.3
Eastern Europe	2,600	3,300	4,100	5.2
Western Europe	3,060	3,990	4,905	5.4
Japan	1,060	1,430	2,370	9.4
ASEAN Group	85	137	205	10.3
Australia New Zealand	63	525	1,580	43.1
Other Asian	378	600	800	8.7
Mexico	145	200	720	19.5
Central and South America	205	303	422	8.4
Middle East/Africa	85	120	815	28.6
Other	80	128	200	10.7
Total	11,511	16,048	23,867	8.4 (average)

SOURCE: Office of Technology Assessment.

Table 5C-13.—Global Methanol Market by End Use, 1981 (thousand metric tons)

Chemical applications	11,061
MTBE	350
Gasoline blending	390
Power generation	10
Total	11,811

SOURCE: Office of Technology Assessment.

Table 5C-14.—Global Methanol Supply/Demand Balance[a] (thousand metric tons)

	1981	1985	1990
North America:			
United States	300	155	(1,400)
Canada	200	1,370	1,440
Eastern Europe	100	600	800
Western Europe	(580)	(1,740)	(3,105)
Japan	(326)	(1,030)	(1,970)
ASEAN	(55)	723	1,225
Australia/New Zealand	(63)	230	320
Other Asian	(121)	(505)	(600)
Mexico	35	0	810
Central and South America	(75)	32	233
Middle East/Africa	345	1,200	2,065
Other	(80)	(128)	(200)
Total	(320)	907	(382)

[a] Due to timing uncertainties associated with the growth in fuel demand, no attempt was made to zero balance trade as was the case with other products in this study. Parentheses indicate net imports.

SOURCE: Office of Technology Assessment.

Table 5C-15.—United States Methanol Demand (thousand metric tons)

	1980	1981	1985	1990	Compound annual growth rate, % 1981-90
Applications:					
Formaldehyde	1,280	1,290	1,630	1,880	4.3
Dimethyl terephthalate	147	145	160	160	1.1
Methyl halides	238	240	335	405	6.0
Methylamines	168	165	195	228	3.7
Methyl methacrylate	153	150	222	310	8.4
Solvents	315	320	395	485	4.7
Miscellaneous	267	500	638	847	6.0
Subtotal	2,568	2,810	3,575	4,315	4.9
Emerging applications:					
Acetic acid	315	420	450	700	5.8
MTBE	165	150	450	555	15.7
Gasoline	90	120	500	1,300	30.3
Power Generation	15	10	50	300	45.6
Subtotal	585	700	1,450	2,855	16.9
Total demand	3,153	3,510	5,025	7,170	8.3

SOURCE: Office of Technology Assessment.

Table 5C-16.—Global Fertilizer Demand (thousand metric tons)

	1979-80	1984-85	1989-90	Compound annual growth rate, % 1980-90
Asia/Oceania	3.8	4.9	5.9	3.9
Indian Subcontinent	4.8	7.8	11.4	7.2
People's Republic of China	7.0	9.7	13.2	5.7
United States	9.9	11.8	13.3	2.1
Canada	0.7	1.0	1.2	3.9
Latin America	2.8	4.5	6.3	6.9
Middle East	1.2	1.5	2.0	5.6
Africa	1.5	2.2	3.0	6.2
Western Europe	9.2	10.4	11.8	2.1
Eastern Europe	13.3	15.0	19.0	3.6
Total	54.2	69.8	87.1	4.3

SOURCE: Office of Technology Assessment.

Table 5C-17.—Global Ammonia Demand (thousand metric tons)

	1979-80	1984-85	1989-90	Compound annual growth rate, % 1980-90
Asia/Oceania	5.4	6.5	7.7	3.1
Indian Subcontinent	2.9	6.4	10.0	9.6
People's Republic of China	6.3	8.7	12.7	6.5
United States	15.1	15.2	17.0	1.2
Canada	1.5	1.8	2.3	3.9
Latin America	2.0	4.4	6.5	9.2
Middle East	1.4	2.2	3.2	8.5
Africa	1.0	2.1	3.1	11.2
Western Europe	13.7	14.6	16.4	1.8
Eastern Europe	19.4	25.3	29.6	3.8
Total	68.7	87.2	108.5	4.1

SOURCE: Office of Technology Assessment.

Table 5C-18.—U.S. Ammonia Demand (thousand metric tons N)

	1978-79	1979-80	1984-85	1989-90
Synthetic fertilizer N production	10,906	12,015	11,235	12,330
Ammonia demand:				
Fertilizers	11,260	12,175	11,580	12,720
Industrial demand	3,060	2,940	3,690	4,315
Total	14,320	15,115	15,270	17,035

SOURCE: Office of Technology Assessment.

Table 5C-19.—U.S. Nitrogen Imports, 1979-80

Country	Metric tons
Canada	847
U.S.S.R.	689
Mexico	286
Trinidad/Tobaga	276

SOURCE: Office of Technology Assessment.

APPENDIX 5D: REFINING CAPACITY IN THE MIDDLE EAST

The close relationship which exists between petrochemical production and refinery product mix makes the status of Middle Eastern refining capacity and future plans important.[1]

Surplus capacities and low operating rates have resulted in poor profitability in the world refining industry in recent years. Despite this, plans for construction of new distillation capacity in the Middle East have continued unabated through the late 1970's and into the 1980's. At the end of 1981, plans were announced for new projects that would increase world crude distillation capacity by approximately 10 million barrels per calendar day (mmb/cd) or 12 percent over current capacity. In view of small predicted growth in demand and a current world overcapacity in excess of 20 mmb/cd, if these were to be completed, the world surplus would surpass 30 mmb/cd, for a surplus of 50 percent. The fact that capacity is planned does not, of course, mean that it will actually be built. Fesharaki[2] predicts that as much as 7.6 mmb/cd will come onstream, with 60 percent of this likely increase coming from major crude oil exporters—OPEC, Mexico, and Egypt. About half of the planned capacity increase in OPEC nations is already under construction, while most of the other OPEC projects planned for the mid-1980's have already gone through the feasibility and engineering stages.

There are several reasons for OPEC nations to push ahead with downstream processing. Four of them, however, may ensure their aggressive pursuit of oil refining as a downstream operation. These are: 1) limited alternative development opportunities within many OPEC nations; 2) massive amounts of capital can be channeled into these prestigious and visible investments without contributing significantly to inflation in the domestic economy; 3) OPEC nationals have already achieved considerable experience and success in the hydrocarbon sector; and 4) these countries hope to capture a major share of the world market. Table 5D-1 shows present and planned refining capacities in OPEC and the Gulf through 1986. More than a 50-percent increase in OPEC capacity is planned for the mid-1980's.

Kuwait Petroleum Corp. (KPC) has acquired West European firms such as Gulf Italiana SPA, allowing it to market oil output in the form of products rather than crude oil. The goal of the strategy is to obtain the maximum value-added. It was reported that in December 1983, 118,000 b/d were sold by KPC and its subsidiaries in Europe, where the firm sells under the Gulf brand name. During the 12 months ending in September 1983, Kuwait sold 5 million tonnes of refined products in Europe, considerably less than Algeria (7.75m) or the Soviet Union (32.5m).[3]

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[1] Material in this appendix comes from: F. Fesharaki and D. T. Isaak, *OPEC, the Gulf, and the World Petroleum Market*, 1983, "Chapter 2—The Refining Industry"; *Competitive Economics of United States and Foreign Refining*, prepared for the U.S. Department of Energy by the PACE Co. Consultants and Engineers, Inc., Houston, Tex., December 1979, Section C and E; National Petroleum Council, Committee on Refinery Flexibility, *Refinery Flexibility*, December 1980, "Chapter 3—Competitive Position of Various Segments of the U.S. Refining Industry," "Chapter 4—Competitive Economics of Supplying Incremental U.S. East Coast Product Demand From Domestic Refineries and Foreign Export Refineries." See also Nigel Harvey, "What Future for Arab Refiners?," *Middle East Economic Digest*, Feb. 3, 1984, pp. 20-22; and John Tagliabue, "Europe's Worried Refiners," *The New York Times*, May 1, 1984, p. D1.

[2] Ibid, p. 86.

[3] See Richard Johns, "Kuwait Takes Up Gulf Oil's European Mantle," *Financial Times* (London), Feb. 1, 1984, p. 11.

Table 5D-1.—Current and Projected Refining Capacity in OPEC and the Gulf, 1981-86
(thousands of barrels per calendar day)

	1981	(+) Under construction	(+) Additional planned	(=) 1986
Iran[b]	1,235	—	—	1,235
Iraq[b]	249	140	—	389
Kuwait	554	58	154	766
Qatar	14	47	—	61
Saudi Arabia[c]	787	734	466	1,987
UAE	126	56	172	354
OPEC Gulf	2,965	1,035	792	4,792
Algeria	442	—	344	786
Ecuador	87	—	108	195
Gabon	20	—	—	20
Indonesia	486	196	265	937
Libya	142	220	—	362
Nigeria	260	—	—	260
Venezuela	1,349	—	150	1,499
Other OPEC	2,786	406	867	4,059
Total OPEC	5,751	1,441	1,659	8,851
Bahrain	274	—	—	274
Oman	47	—	—	47
Other Gulf	321	—	—	321
Total OPEC and Gulf	6,072	1,441	1,659	9,102

[a] As discussed in the text, plans exist for refining additions beyond those shown in this table; some are spurious, some speculative, and others fairly clearly planned, but for the post-1986 period.

[b] The situation in Iran and Iraq is confused. The extent of the war damage is not clear. Moreover, both countries had completed new capacity on the eve of the war, and both had plans to scrap someoutmoded capacity. These capacity estimates should be treated with circumspection.

[c] Saudi Arabia includes Neutral Zone refining of 80 mb/cd.

SOURCE: Fesharaki, 1983.

CHAPTER 6

Telecommunications Technology Transfers

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CHAPTER 6

Telecommunications Technology Transfers

INTRODUCTION

The countries of the Middle East realize the importance of modern, efficient telecommunications systems to their future development and security. Middle Eastern leaders consider telecommunications as important a part of their infrastructure as roads and ports. This is reflected in several of the 5-year plans and budgets of Middle Eastern nations. Kuwait, in particular, wants to become a regional and international financial center and has developed telecommunications capabilities necessary to reach this goal. The centrality of telecommunications to development planning is also reflected in cooperative regional efforts such as Arabsat, a regional satellite communications system.

There is today great disparity in telecommunications systems in the Middle East. Some countries, like Kuwait and Saudi Arabia, have extremely modern, efficient systems; others like Egypt have comparatively dated equipment and systems which are much less reliable.

With the notable exception of Algeria (and in a few cases, Egypt), the countries under study have opted for the most advanced telecommunications systems available—whether microwave transmission networks, satellite communications, or automatic electronic switching. Kuwait and Saudi Arabia in particular have used their financial resources to purchase state-of-the-art technology. This has allowed them to "leapfrog" conventional technology, becoming testbeds for some technology so new that it is not installed anywhere else in the world. Iran and Iraq found some of the most sophisticated systems as best suited to their needs. Algeria, in contrast, opted for more conventional technologies in order to lessen dependence on foreign expertise and to promote indigenous equipment manufacture.

Middle Eastern countries, through their PTT's (post, telephone and telegraph) ministries have made major investments in telecommunications infrastructure during the past decade. In many cases, subscribers have only recently begun to feel the impact of telecommunications, yet the experience has generated a set of rising expectations and further demand for sophisticated equipment and services among business and industry, government agencies, the military services, and residential users. A number of factors have contributed to this growing demand for telecommunications, among them the perceived novelty of the improvements, prestige associated with telecommunications as a sign of modernity, and the utility of improved communications in achieving other development goals.

The rapid expansion of national and regional telecommunications systems in the Middle East has made the region a major new market for equipment sales, operation and maintenance, consulting services, and training. This continuing transfer of technologies has increased the capabilities of these countries to expand their commercial and industrial bases; to improve domestic communications; and to explore possibilities for regional and international cooperation. On the other hand, continuing dependence on foreign suppliers, and the use and control of the systems, are sometimes controversial issues associated with these technology transfers.

This chapter first examines the present status of the telecommunications systems in each of the six study countries and in the region. Perspectives of recipient and supplier countries and firms are then discussed. U.S. suppliers have won sales of all types of telecommunications equipment and services in countries such as Saudi Arabia and prerevolutionary Iran, but overall, U.S. firms have not been a dominant force in telecommunications trade in the region. In the world telecommunication market, U.S. firms have lost ground to Japanese suppliers during the past decade.

In assessing competition among suppliers and implications for U.S. policy, special attention is paid to the role of supplier government financing in competition for sales of telecommunication technology.

TELECOMMUNICATIONS IN THE MIDDLE EAST

TELECOMMUNICATIONS SYSTEMS

Telecommunications systems generally include: 1) telephone and telex equipment, 2) transmission equipment, 3) mobile radio, 4) video and radio broadcasting equipment, and 5) data communications equipment. During the past decade, telephone and telex have been the major imports of the Middle East, making up well over 50 percent of total imports of telecommunications equipment and services for most countries. Transmission equipment imports have been the second largest, valued at 20 percent of total telecommunications imports in some cases. The following section briefly explains the application of the major telecommunications technologies in each of these categories.

Telephone and Telex Equipment

A standard telephone set consists of an apparatus that includes a telephone transmitter, receiver, and switchhook. Other types of telephone equipment used onsite by a subscriber are coin telephones, answering machines, intercoms, call restrictor devices, and station accounting systems. A telex is a direct-dial telegraph service wherein subscribers can communicate directly through circuits of the public telegraph network. Teleprinters (instruments with a typewriter keyboard and printer) send and receive messages through the system.

Both telephone and telex use switching mechanisms to interconnnect the circuits of the equipment. Manual switching requires a switchboard staffed by an operator, while automatic switching can be performed electromechanically or electronically. Electromechanical switching uses analog technology, wherein mechanical (dialing) and voice signals are transformed into a continuous signal of varying frequency and used to activate the switches. Electronic switching uses electronic devices to connect circuits and usually involves computer-controlled (software) circuitry. It can operate using analog or digital technology (see box A).

Digital technology converts dialing and voice signals into discrete electrical pulses that form computer-understandable streams of information. Because it uses the power of a computer, digital switching technology can offer additional subscriber services such as abbreviated dialing, call transfer, conferencing, speed calling, call cost readouts, and reliable billing. Technically, digital technology is an improvement over analog equipment because it results in less deterioration of the transmitted signal, higher speed, and simultaneous transmission of multiple calls. At the same time, because digital technology is more sophisticated, use by local personnel in developing countries may be more difficult. Indeed, software engineers for digital systems are in short supply worldwide, not just in developing countries.[1]

Almost all of the world's telephone plants evolved using analog transmission; most of them will remain so for years to come because of the billions of dollars invested. However, it is probable that if telecommunications companies were to start anew, telecommunications channels would be almost entirely digital, with the possible exception of the local "loops" be-

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[1] Information provided by Continental Page, December 1983.

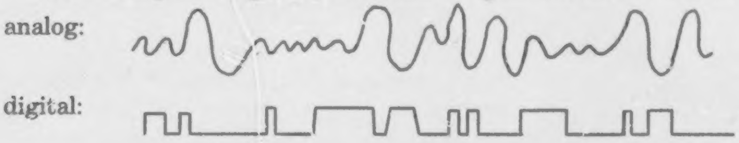
Box A.—Analog v. Digital Transmission

There are two basic ways in which information of any type can be transmitted over telecommunication media: analog or digital.

Analog transmission entails transmittal of a continuous signal in a continuous range of frequencies. Sound consists of a continuous spread of frequencies from about 30 to 15,000 Hz (Hertz, or cycles per second), or at most 20,000 Hz for persons with excellent hearing. (Sound cannot be heard by humans below 30 or above 20,000 Hz.) Although it is technically possible to transmit across this large range over the telephone wires, the telephone companies, conscious of costs, transmit a range of frequencies that may vary only from about 300 to 3,000 Hz, a range wide enough to make a person's voice recognizable and intelligible. When telephone signals travel over lengthy channels, they are packed together, or **multiplexed**, so that one channel can carry as many such signals as possible. The multiplexed signals have different frequencies so that they do not interfere with one another, but they are still transmitted in an analog form.

Digital transmission means that a stream of on/off pulses is sent, such as occurs in computer circuits. These pulses are referred to as **bits**. It is possible today to transmit at extremely high bit rates such as 4,800, 9,600, and 56,000 bits per second.

An analog and digital transmission signal are shown below:



A transmission path can be designed to carry either type of transmission: this applies to all types of transmission paths, whether wire pairs, high-capacity coaxial cables, microwave radio links, satellite, waveguides, or fiber optics. Any type of information can be transmitted in either an analog or digital form. For example, the telephone channel is generally an analog channel, but computer data can be sent over the telephone lines by using a **modem** (modulator/demodulator), which converts the digital data into a continuous (analog) range of frequencies. In a similar manner, any analog signal can be converted to digital signals for transmission. Codecs are circuits that convert signals such as speech and television into a bit stream and convert such bit streams back into the original signal.

SOURCE: Adapted from James Martin, *Future Developments in Telecommunications* (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1977), ch. 4.

tween a subscriber and the nearest switching office. Some developing countries, such as Kuwait and Saudi Arabia, are installing pulse code-modulated (PCM) systems in which voice and other analog signals are converted into a stream of bits that look like computer data.

The economic factors favoring digital over analog transmission stem from two aspects of these technologies. First, it is becoming possible to build channels of high bandwidth, those with high information-carrying capacity. Thus, many existing wire-pair channels, which represent an enormous financial investment, could be made to carry much more traffic. Second, whenever the signal is amplified in analog transmission, the noise and distortion is amplified with it. As the signal passes through its many amplifying stations, noise is amplified and cumulative. With digital transmission, however, each repeater station regenerates the pulses and new clean pulses are reconstructed and then sent to the next repeater. Thus, the digital pulse train is more impervious than the analog to distortion in the signal.

Several factors are thus pushing the economic calculus in favor of digital transmission:

1. the trend to much higher bandwidth facilities;
2. the decreasing cost of logic circuitry, which is used in coding and decoding the digital signals and in multiplexing and switching them;
3. the increase in capacity that results from use of digital repeaters at frequent intervals on a line;
4. improvements in codec design, enabling speech to be encoded into a smaller number of bits;[2] and
5. the rapidly increasing need to transmit digital data on the networks.

Facsimile systems transmit information on a written page by scanning the page electronically and more rapidly than one character at a time. Their benefits include more rapid transmission of written material than via telex, the elimination of typographical errors, and the possibility of transmitting graphics. Facsimile machines are gaining popularity in the Middle East, where difficulties have been encountered in transferring Arabic script to electronic keyboards. Current choices in facsimile systems involve low-, medium-, or high-speed models and analog or digital equipment.

Transmission Equipment

Transmission equipment enables transmission of information within the exchange area and on short- or long-distance hauls. The transmission can involve physical connections between two points ("wire"), or transmission which occurs through a space ("wireless"). It can involve analog technology that enables only one telephone conversation per circuit, or digital technology that enables many telephone conversations to be transmitted simultaneously on one circuit. The advantages of digital over analog technology include higher reliability, better reception, and the transmission of voice, data, text, and video over the same circuit.

Transmission lines include wire and cable for trunk lines that connect subscribers between two central offices or switching exchanges. Also included are coaxial cables which are transmission lines consisting of a small copper wire insulated from another conductor of larger diameter (usually a copper braid). Coaxial cable is often more desirable than wireless transmission equipment in that it is more secure for transmitting sensitive information and it provides high-quality service unaffected by changing weather conditions. Other transmission lines include wiring within the exchange and cable laid underwater (submarine cable).

High-frequency radio (other than mobile) involves wireless transmission and is often used for military applications. Microwave uses high-frequency, highly directional radio signals (above 890 megacycles per second) to transmit multiple communications channels (broadcast or video circuits between two points that have relay stations). The quality of transmission is comparable to that of coaxial cable. Repeater or relay stations receive signals through antennas, amplify them, and retransmit the signals to the next station.

Two types of microwave systems are available, line-of-sight and over-the-horizon. Line-of-sight systems permit transmission in relay links of about 30 to 35 miles on average, although single links of 100 miles may be possible if ground terrain permits. Transmission can extend to distances of 3,000 to 4,000 miles with many links. In comparison to cable transmission, attractive features of line-of-sight systems are high and flexible channel capacity, easy expansion of capacity, shorter installation time, and better adaptation to difficult terrain. Over-the-horizon systems often use tropospheric scatter technology to span longer distances (up to 700 miles) without relay links. Signals are diffracted in the atmosphere. Because of the long distances, these systems are useful for transmitting across large bodies of water. They require very large antennas and very high-powered transmitters and thus tend to be costly and sometimes unreliable.

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[2] See Box A for definition of codec. Bits are binary digits which can take on one of two values, typically written as "0" or "1."

Fiber optics are composed of fine glass fibers that transmit information by converting digital electrical impulses into light beams. The information is carried through the fibers, which physically connect sender and receiver. These fibers are smaller and lighter than conventional copper wires and can carry much more information than a typical metal cable using digital signals. A single optical fiber, for example, may carry thousands of telephone calls. Optical fibers can carry a mix of signals simultaneously—telephone, cable television, radio, video, and data. They can also transmit signals four times farther than metal cables without repeaters to amplify the signal.

The fibers are manufactured with glass of high silica content and few impurities. The raw materials used in making glass fibers, unlike copper, are among the world's most plentiful substances.[3] They also do not conduct electricity and are not subject to electromagnetic interference, which means less "noise" in data communications. Fiber optic transmission is difficult to intercept or interfere with and is adaptable to hazardous conditions, making it useful in many military applications. This technology is, however, still comparatively experimental for long-haul distances and costs are higher than for other transmission methods.

There are three types of multiplexers, which enable the simultaneous transmission of several channels on a single circuit. There are three types. Frequency division multiplex transmits two or more signals on a common path by using different frequency bands for each signal. Those with large capacity can carry, for instance, one television channel and 600 to 900 telephone channels on a single microwave carrier. Time division multiplex transmits two or more signals on a common path by using different time intervals for different signals. This technique is less expensive to implement than frequency division multiplex, but is not compatible with frequency division multiplex systems and is not suitable for a large number of channels. Finally, pulse code modulation obtains a number of channels over a single path by modulating each channel on a different frequency and demodulating it at the receiving point.

Satellite transmission uses a satellite placed in geostationary orbit[4] to communicate telephone, radio and television, and data signals. The satellite operates essentially as a microwave relay in the sky, receiving microwave signals and retransmitting them to Earth. The Earth station is a dish-type antenna that receives and transmits.

Mobile Radio

Mobile radio involves radio service between a fixed station and one or more mobile stations. Land mobile radio includes conventional mobile radio and mobile telephone (mobile stations hooked into a central public telephone switching network). The new cellular type of mobile telephone system allows a higher user

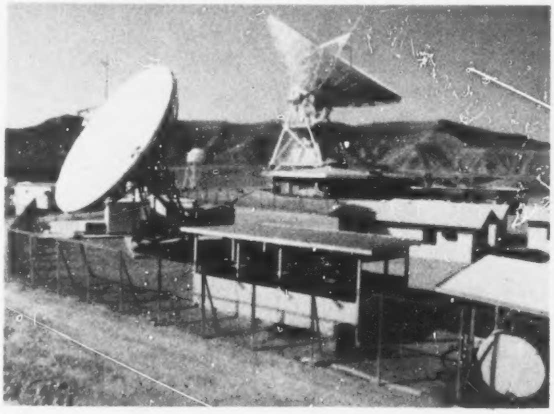

Photo credit: Harris Corp.

Earth Station, Riyadh, Saudi Arabia

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[3] James Martin, *Future Developments in Telecommunications* (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1977).

[4] A geostationary orbit is that of an object traveling about the Earth's equator at a speed matching the Earth's rotation, thereby maintaining a constant relation to certain points on the Earth.

density in a geographic locale but requires sophisticated computer control. Paging systems are small frequency-modulated (FM) one-way radio receivers which page individuals. Many pagers can occupy a channel if receiving only data messages rather than voice. Current choices include tone only or tone and voice paging. Marine radio involves radio transmission between two units at sea or between sea and land, and air-ground communications involve radio transmission between aircraft and the ground for navigation and communications purposes.

Video and Radio Broadcasting Equipment

Closed circuit television (CCTV) includes cameras, monitors, receivers, control consoles, scan converters, and lines interconnecting the system with the receivers. Radio broadcast transmitters and studio equipment include amplitude-modulated (AM) and FM transmitters, antennas, lines, consoles, and recording and playback equipment. Television broadcast transmitters include very high frequency (VHF) and ulta-high frequency (UHF) transmitters, antennas, lines, consoles, recording and playback equipment, cameras, and mobile vans.[5]

Data Communications Equipment

Data communications equipment connects computers to the telephone network. Up to 4,800 bits per second of data can be transmitted on regular voice telephone lines. Modified lines enable faster data transmission. This equipment includes concentrators, modems, multiplexers, and data communications switching.

MANPOWER REQUIREMENTS

From the perspective of Middle Eastern countries importing telecommunications technologies, a central concern is with manpower requirements for operating and maintaining equipment. Contracts for supply of equipment almost always include requirements that the supplier maintain the equipment for some years. As the discussion that follows shows, some of the most advanced telecommunications technologies require less maintenance than traditional equipment. Telephone operations (the center of these systems) remain, however, labor-intensive.

Because skilled manpower shortages are a major factor constraining effective absorption of telecommunications technologies in many of the countries under study, it is important to note that modern analog telephone systems are more people-intensive than digital electronic systems. As a rule of thumb, approximately 150 employees are required for every 10,000 lines of analog equipment, compared with 135 to 145 employees for digital lines. The skill mix also differs, with more college-trained technical personnel and computer and programing specialists required for digital systems.

An advantage of electronic switching systems (ESS) compared to electromechanical switching systems (EMSS) is that EMSS requires 10 to 20 inside plant personnel per 10,000 lines in order to maintain (continually oil and adjust) the switches. The work force consists primarily of semiskilled laborers. In the electronic system, only one inside plant person per 10,000 lines is needed; the system is almost unattended. The central operation and maintenance center has a computer monitor that keeps track of the system. If a fault occurs in a line, it is registered and reported on teletype. The system identifies the faulty printed circuit card, and a skilled worker (who has a supply of all needed types of circuit cards) is then sent to replace the card. The repair is thus a card-changing procedure, not a "work-bench" operation. The faulty card is returned to the manufacturer for repair or disposal.

Servicing and maintaining telecommunications equipment is a major issue in the Middle East, and particularly in Saudi Arabia and Kuwait. Saudi nationals are generally not trained in maintenance functions; these tasks are left to foreign nationals. In Kuwait, the Japanese consortium that installed and conducted initial servicing on the telephone systems was called back after 3 years of local maintenance; the local maintenance reportedly left the system in need of major overhauls.[6]

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[5] "Very high frequency" refers to a band of radio frequencies between 30 and 300 megahertz. "Ultra-high frequency" refers to a band of radio frequencies between 300 and 3,000 megahertz.

All of the major suppliers provide extensive training programs. U.S. firms that were interviewed, however, noted that nationals often lack motivation and that supplier personnel normally are required to perform maintenance. With foreign contractors involved in servicing and maintenance, the installed equipment reportedly functions well. Analysis of contracts in the six nations under study indicates that much of the equipment purchased since the early 1970's is still serviced by foreign suppliers.

The harsh physical environment of the Middle East further hampers maintenance of telecommunications equipment. Digital systems require air conditioning and special modules to protect equipment from dust and sand. Where required, these elements are always included by suppliers as part of the equipment package. These special applications further complicate maintenance procedures and normally prolong dependence on the supplier.

These problems associated with maintenance clarify the preference of Middle Eastern leaders for some of the more advanced technologies. Digital switching, for instance, is less expensive to maintain then analog switching. Similarly, microwave relays can often last thousands of hours between repairs, while cable networks require almost daily maintenance.

Manpower requirements in telecommunications are geared heavily toward clerical and craft workers. As a point of reference, in the United States the telephone subsector of communications clerical workers comprise 45 percent of the total work force, and craft workers 33 percent.[7]

Photo credit U. S. Agency for International Development

Telephone equipment provided to Egypt under the U. S. Commodity Import Program

Telephone operations tend to be very labor-intensive. The more advanced the telecommunications technology, the higher the proportion of professional, technical, and managerial personnel required and the fewer total workers required. The skill mix also differs, with more college-trained technical personnel and computer and programing experience required for digital systems operations. Skilled manpower shortages have been a major factor constraining effective telecommunications technology absorption in the Middle East. In Egypt where unemployment has been a problem, decisions about telecommunications technologies have been made to take account of broader social goals. The result has been that operations are less efficient, judged by international standards.[8]

TELECOMMUNICATIONS SYSTEMS IN THE MIDDLE EAST

Saudi Arabia

Saudi Arabia has taken the advanced-technology route to telecommunications. Working closely with foreign firms, the country has built an extremely efficient telecommunications network.

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[6] "Japan Telecommunications Engineering and Consulting (JTEC)—Kuwait's Reluctant Partner," *Middle East Economic Digest*, Oct. 15, 1982, p. 90.

[7] U.S. Bureau of Labor Statistics, Bulletin #2086, April 1981.

[8] For example, ARENTO in Egypt employs more personnel than are needed in order to help solve the country's high unemployment problem. The 1981 statistics show that Egypt had over 1,000 employees per 10,000 lines (AT&T Long Lines, *The World's Telephones*, Morris Plains, N.J., 1982), which is six or seven times greater than the ratio deemed adequate for efficient operations.

The network was greatly expanded in the last decade, with the number of exchange lines quintupling between 1976 and 1981. In 1982 there were 789,000 telephone subscribers, or 11.2 lines per 100 inhabitants, just over the world average of 10.5 lines.[9] This coverage is quite extensive by Middle Eastern standards, given that the World Telephone Zone 9 (Middle East and Southeast Asia) average is 1.1 lines per 100 inhabitants. Much of this telephone expansion began in 1978 with the awarding of a contract to L. M. Ericsson of Sweden and Philips of the Netherlands to install 480,000 new telephone lines.

Of the six countries under study, Saudi Arabia has the second highest percentage of automatic telephone operation, with 99.4 percent being automatic switching system control (97.1 percent electronic control [ESS] and 2.3 percent electromechanical control [EMSS]). Saudi Arabia is also the only country which has private telephone operations, which encompass 12 percent of the total telephones. With regard to telephone use in the Kingdom, 70 percent are for residential use (60 percent-main, 10 percent-extension) and 30 percent are for business use (20 percent-main, 10 percent-extension).

Several large-scale projects have been completed to enhance the transmission network. The Backbone Telecommunications Project consists of 1,420 kilometers of east-west coaxial cable between Taif and Dammam via Riyadh and a 160-kilometer microwave link between Jeddah to Taif via Buhr, Mecca, and al-Hada. The work was performed by Sartelco, a Saudi Arabian-based subsidiary of Sirti (Italy), using cable from Philips.

The Intra-Kingdom Microwave Communications Project enhances long-distance transmission for telephone and television and covers 10,000 kilometers. It links Al-Ain with King Khalid City, Hofuf, Salwo, and Dawaheen, and Riyadh with Dormah and Zolam. The system was implemented by Western Electric International of the United States and includes 300 microwave towers with a 35,000-line capacity. Microwave links have also been established between Saudi Arabia and Sudan, with a capacity of 300 telephone lines and 92 television channels. A smaller, local digital microwave system was implemented by Telettra of Italy in Riyadh to link government buildings with certain government official residences.

Saudi Arabia's domestic satellite communications network, Domsat, links 11 cities—Jeddah, Riyadh, Medina, Hayel, Abha, Borayda, Tabik, al-Bahah, Jizan, Najran and al-Jawf. Harris Corporation of the United States supplied the mobile Earth stations with 11-meter antennas to link with Intelsat satellites. As of 1979, three Earth stations for use through Intelsat were installed by Mitsubishi Electric Company of Japan—two in Riyadh and one in Taif—with a total of 569 circuits.[10]

Saudi Arabia has begun to experiment with domestic optical fiber transmission systems. A 45-kilometer, 6-fiber cable has been installed by Philips in Jeddah and Riyadh. The exchanges have a capacity to handle 1,920 telephone calls per fiber.[11]

By 1980, 1,200 public pay telephones had been installed in 23 towns and cities. By 1982, 2,000 mobile telephones had become operational, having been integrated into the exchanges installed earlier using Ericsson technology. In addition, a fully electronic, multiplex-exchange telex system was completed in 1979. Using six computers, it has a capacity of 15,000 lines and serves 100 cities and towns. It was developed by a Saudi Arabian prime contractor, Hajji Abdullah Alireza Group, in cooperation with Fredericks Electronics Corporation (U.S.).

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[9] AT&T, Long Lines, *The World's Telephones*, Morris Plains, N.J., 1983. See also Robert Bailey, "Telecommunications," *Middle East Economic Digest*, Nov. 18, 1983, p. 14.

[10] J. Chamieh (ed.), *Saudi Arabia Yearbook* (Lebanon: The Research and Publishing House, 1981).

[11] International Trade Administration, U.S. Department of Commerce, "Market Survey: The Telecommunications and Electronic Data Communications Market in the Middle East," Washington, D.C., 1982.

There are currently 12 telex machines per 10,000 inhabitants in Saudi Arabia, which, on average, is the highest ratio in the world.[12] Facsimile terminals and other data transmission equipment are also being imported. Facsimile machines are popular in the Middle East, since they scan and transmit an entire page electronically and thus are ideal for communicating information in Arabic.

Saudi Telephone is managed by Bell Canada under contract. Bell Canada has also assisted in establishing eight repair service centers—in Riyadh, Jeddah, Dammam, Abha, Taif, Mecca, Medina, and Borayda. Ericsson has established four computerized operation and maintenance control centers at Riyadh, Jeddah, Damman, and Taif to trace faults in the system. An engineering department has been set up with recent Saudi engineering graduates, assisted by Bell Canada staff. Also, two permanent 32-room training facilities in Riyadh and Jeddah with two mobile training units have been established. Bell Canada conducts training, averaging 60 hours per student, in Arabic and English with advanced courses provided in Canada.[13]

Saudi Arabia has adopted advanced technology in all telecommunications sectors—switching, transmission networks, mobile telephones, and telex. Partly because of this, Saudi Telephone has improved productivity and reduced its manpower ratio by 10 percent to 43 employees per 1,000 working lines. During this rapid expansion period, despite continuing system enhancements and increased usage, service is reportedly satisfactory. In 1980, more than 1 million international calls per month were completed by 500,000 subscribers (annual average of 24 calls per subscriber); 58 percent of these calls were made directly by the subscriber.[14] In 1981, total international calls topped 17 million, with the most calls going to (rank ordered) the United States, Kuwait, Great Britain, and Bahrain.[15]

The system in Saudi Arabia is highly responsive. Bell Canada reported that: 1) 94 percent of customers in Riyadh receive operator services within 10 seconds, 2) 75 percent of national long distance calls are answered within 10 seconds, 3) almost 80 percent of directory assistance calls are answered within 10 seconds, and 4) nearly 50 percent of calls to international operators are answered within 10 seconds. The system is also reliable: 90 percent of all calls are successful, and 98 percent of subscribers receive a dial tone within 3 seconds.[16]

During the 1970's, imports of telecommunications equipment underwent tremendous growth—from OECD countries it went from $17.4 million in 1971 to $740.6 million in 1980 (in nominal dollars).[17] The beginning of the Second Development Plan in 1976 ushered in a rapid increase in telecommunications imports. Also, a large influx of population in the cities between 1974 and 1980 increased demand on the existing infrastructure and spurred major telecommunications expansion projects, carried out primarily by Ericsson of Sweden and Philips of the Netherlands. During 1970 to 1980, the volume of telecommunications imports amounted to 2 percent of Saudi Arabia's total import volume and almost 4 percent of world imports of telecommunications equipment. A slight retrenchment in telecommunications import spending began in 1980, owing to an increased focus on agriculture, industry, and health sectors in the Third Development Plan and to completion of some major segments of the networks.

Three supplier countries are prominent in Saudi Arabia's telecommunications market, as shown in table 51. Table 52 shows selected telecommunications contracts awarded by Saudi Arabia. Firms from the Netherlands and Sweden together have accounted for more than half of the contracts, in terms of dollar value, in recent years. U.S. firms had a 16 percent share in 1980, which represented a major shift from the mid-1970's, when they had approximately a 30 to 48 percent share of the Saudi Arabian telecommunications market.

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[12] Ibid.

[13] *Middle East Economic Digest*, Sept. 18, 1981.

[14] Robert Bailey, "Saudi Arabia, Telecommunications, Electronics, and the Middle East—Special Report," *Middle East Economic Digest*, January 1981; International Telecommunication Union (ITU), *Yearbook of Common Carrier Telecommunication Statistics*, Geneva, 1980.

[15] AT&T, op. cit., 1983.

[16] *Saudi Arabia Yearbook*, op. cit., 1981.

[17] SITC #764, 7249. See table 51.

Table 51.—Market Shares of Telecommunications Equipment Exports to Saudi Arabia From OECD Countries, 1971, 1975-80 (SITC 764 or 7249)

	Canada	United States	Japan	France	West Germany	Italy	Netherlands	United Kingdom	Sweden	Total exports (in 000 U.S. $)
1971	0.3	15.1	2.4	11.1	1.4	2.2	0.0	55.9	10.4	17,406
1975	0.4	21.4	8.5	2.9	8.2	7.9	0.7	18.5	14.1	92,814
1976	6.5	28.0	3.2	1.6	3.8	5.4	2.3	36.5	10.6	134,756
1977	2.8	47.9	4.7	6.3	5.2	5.3	0.6	14.8	10.8	288,246
1978	1.5	33.9	4.2	1.8	4.1	4.0	21.5	9.4	18.5	568,962
1979	1.4	17.7	4.3	2.3	2.7	4.3	31.6	13.3	19.7	883,836
1980	0.8	15.9	4.9	4.0	4.4	0.7	44.0	7.1	16.0	740,561

NOTE: Market shares calculated as value of exports reported by exporter as a percentage of total telecommunications exports to recipient reported by all OECD exporters.

SOURCE: Compiled for OTA from Organization for Economic Cooperation and Development (OECD), *Trade of Commodities: Market Summaries*, Exports (1971, 1975-80).

Table 52.—Selected Telecommunications Contracts in Saudi Arabia

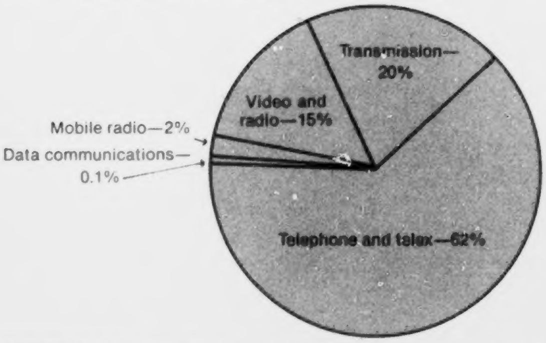
Supplier country	Year	Supplier	Description	Amount (millions of dollars)
Canada	1978	Bell Canada	Management of Saudi telephone system	1,000
Norway	1977	Teleplan	Management of telephone network expansion	185
United Kingdom	1978	Preece, Cardew, and Rider	Design and supervision of telecommunications network	22.3
France/Saudi Arabia	1982	Cegelec Contracting Co. (joint venture company)	Construction and maintenance of communication network	14.3
Italy/Saudi Arabia	1981	Sirti/Sartelco	Installation of telecommunications system in Yanbu	65
Japan	1982	Nippon Electric Co. (NEC)	Supply of fiber optics communications system linking Ras Tanura with Barri and Abgaig with Dhahran	16
Netherlands/Sweden/ South Korea/Norway	1977 (6 phases)	Philips/L. M. Ericsson/ Dong Ah/Norconsult	Increase telephone network from 200,000 lines to 1.2 million by installing world's first stored program control (SPC) system	4,400
United States	1979-82 (4 phases)	Litton Industries (Sub: Aydin Corp. and Karkar Electronics)	Improve military communications systems, provide national air defense communications network, provide digital multiplex equipment	1,720

SOURCE: Compiled for OTA from selected issues of the *Middle East Economic Digest*.

Saudi Arabia invested between 1974 and 1982, approximately 62 percent of telecommunications expenditures for telephone and telex, 20 percent for transmission, 15 percent for video and radio, 2 percent for mobile radio, and 0.1 percent for data communications (see fig. 10). For telephone and telex (1974-82 total expenditures of $8,035 million), the largest allocations were made in the switching and total communications subsector. U.S. firms maintain slightly more than 30 percent of this market, with firms from Sweden and the Netherlands holding about 20 percent shares each. In transmission equipment sales, firms from South Korea captured 49.2 percent of the sales, due to their role in expansion of the Saudi cable network. In video and radio equipment sales, U.S. firms had a minor share of 7.6 percent, while those from France had 70 percent and dominated this market. U.S. firms had an over 90 percent share in mobile radio and data communications, but these represented only about $290 million total expenditures by Saudi Arabia from 1974 to 1982 (see fig. 11).

By far the major growth areas in Saudi telecommunications over the last decade have been in development of integrated communications systems. The Philips-Ericsson-Dong Ah-Norconsult-Bell Canada consortium has received the major share of this market and has effectively closed off the market to other suppliers. U.S. and U.K. firms have been supplying communications systems for specialized applications such as air traffic control and military and industrial communications.

Figure 10.—Apparent Telecommunications Sector Breakdowns—Saudi Arabia, 1974-82



SOURCES: Compiled for OTA from Intel-Trade; Inbucon, 1980; *MEED: Telecommunications*.

Kuwait

In 1981, Kuwait's telephone exchange capacity reached 286,200 lines, a 100 percent increase over 1979. The number of lines in active use numbered 171,427, with 231,640 telephones connected to these lines. This amounts to about 15.8 telephones per 100 residents, the highest ratio among the six countries in this study. Despite this relative abundance of capacity, forecasts of population growth and business demand have lagged behind actual growth. As a result, while some exchanges have excess capacity, others cannot meet the demand. In some newly developed areas, businesses and residences reportedly must wait 2 to 3 years for a telephone, owing to shortages of lines and equipment. Almost two-thirds of all telephones are residential; the rest serve business.

The system is 100 percent automatic: 89.9 percent EMSS and 10.1 percent ESS. All switching equipment installed between 1980 and 1982 is fully electronic digital systems. There are 16 local telephone exchanges and all telephone operations are government-run. Three Earth satellite stations are linked to both the Atlantic and Indian Ocean Intelsat networks. Domestically, a mobile telephone system is in place, with 4,019 mobile units in use as of 1981. In 1979 an electronic telex enchange of 7,500 lines was completed by Olivetti of Italy.

Kuwait had only one TV broadcasting station in 1979, but a second channel was to be available later that year. The station range includes Bahrain and parts of Iraq and Saudi Arabia. Estimates of TV receivers number 375,000, and radio receivers number 1 million.

The Kuwait telecommunications system has generally been a reliable network. Recently, however, there have been localized problems. Kuwait's development began earlier than that in most neighboring countries and many difficulties can be traced to the strain imposed by explosive population growth on systems be-

Figure 11.—Apparent Market Share, Saudi Arabia, 1974-82

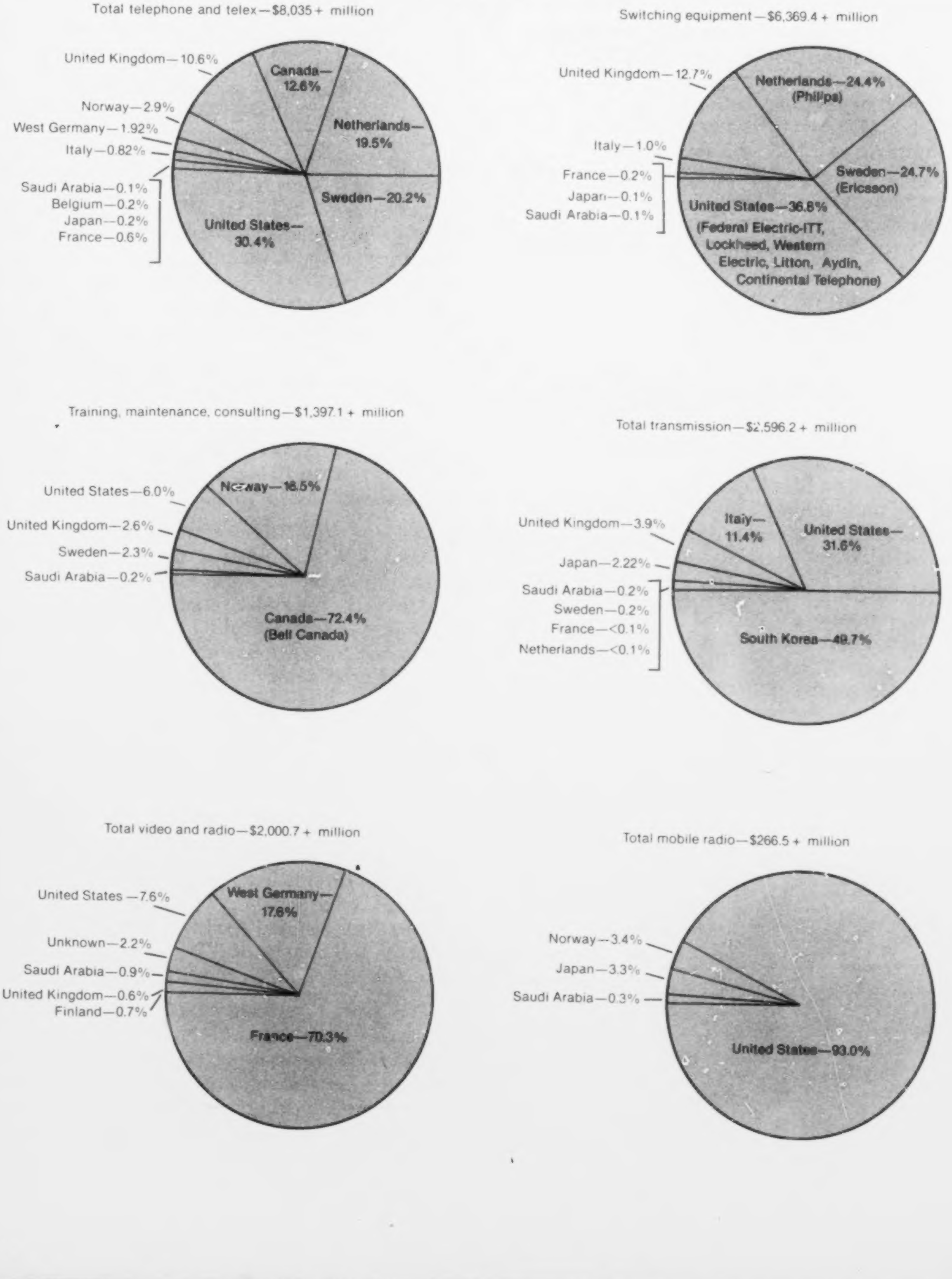
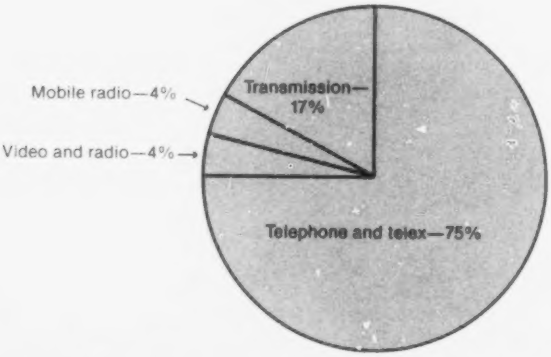


Figure 12.—Apparent Sector Breakdowns—Kuwait, 1974-82



SOURCES: Compiled for OTA from Intel-Trade; U.S. State Department cables.

ginning to age. The Communications Ministry has adopted two sets of measures to deal with the problem—several contracts for rehabilitation of the cable network, and more reliance on microwave links and other technologically advanced equipment. Its major shortcoming is in keeping up with localized demand, which requires accurate planning for exchanges that require excess capacity in order to support future increased needs. One of the worst problems for Kuwait's telecommunications users has nothing to do with outmoded or overburdened equipment, but with routine loss of service due to cutting of cable by contractors working on roads and buildings. To alleviate this problem, a utility management system will be installed by a Japanese consortium at a cost of $28 million. This system will include computerized mapping of all underground utility networks in the 500-square-kilometer city.[18]

Kuwait's average of telephones per 100 inhabitants is 15.8, well above the world average of about 10.5. Moreover, usage of the system by subscribers is the highest among the countries under study—an average 20.4 international calls per subscriber during 1980. While Kuwait's telephone system is the smallest of the six countries, it provides the greatest amount of capacity to its population and is the most heavily used.

Given Kuwait's small population and geographic area, its recent development of the most extensive and most used telecommunications network among the six countries reflects its desire to become a world business and financial center. This requires an excellent communications system, especially internationally. Kuwait's extensive satellite transmission facilities and data transmission capabilities, and its recent purchases of high-technology equipment to expand its telecommunications network are evidence of the commitment to this goal.

Early expansion of oil production capacity of Kuwait in the 1950's resulted in large development expenditures throughout the late 1960's and 1970's. Expenditures in the telecommunications sector reached almost 3 percent of all Kuwaiti imports in 1970. Imports of telecommunications equipment, parts, and accessories from OECD countries rose from $7.7 million in 1971 to $90.1 million in 1980 (in nominal dollars) as shown in table 53 and represented from 0.2 percent to 0.7 percent of world telecommunications imports. Table 53 also lists the market share of telecommunications equipment exports to Kuwait from OECD countries in 1971 and 1975 through 1980.

As shown in the table, Japanese firms have controlled between one-quarter and one-third of Kuwait's telecommunications market during the 1970's. Kuwait's ties with its former colonial ruler Britain are still strong, as evidenced by a large volume of British exports in this sector to Kuwait. Over the last decade, Swedish firms have had several large contracts in telecommunications, but failed to maintain a stable foothold. Firms from West Germany and the United States have succeeded in gaining about 15 percent each of Kuwait's market. Table 54 shows selected telecommunications contracts awarded in Kuwait.

Kuwait's investment in the telecommunications sector from 1974 to 1982 was approxi-

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[18] "Telecoms to Reap Benefits of Investment," *Middle East Economic Digest, Special Report on Kuwait,* May 1984, pp. 29-30.

Table 53.—Market Shares of Telecommunications Equipment Exports to Kuwait From OECD Countries, 1971, 1975-80 (SITC 764 or 7249)

	United States	Japan	Belgium	France	West Germany	Italy	Netherlands	United Kingdom	Sweden	Switzerland	Total exports (in 000 U.S. $)
1971	4.3	38.5	4.9	0.8	4.8	0.0	0.6	15.6	10.9	1.5	7,700
1975	11.8	15.7	2.4	12.5	7.3	4.6	0.4	10.6	30.4	2.2	16,742
1976	26.8	20.0	0.5	18.2	10.1	3.0	0.1	6.1	10.8	0.5	52,701
1977	20.2	22.0	0.4	4.8	3.3	4.2	0.1	21.3	16.8	4.8	55,315
1978	5.8	23.1	1.2	3.8	5.8	1.0	0.6	28.4	17.9	9.1	68,506
1979	5.6	35.6	0.7	2.2	10.3	0.7	0.9	11.7	28.6	1.4	68,534
1980	14.3	26.8	0.5	1.7	15.5	0.8	3.2	23.1	10.8	0.5	90,084

NOTE: Market shares calculated as value of exports reported by exporter as a percentage of total telecommunications exports to recipient reported by all OECD exporters.

SOURCE: Compiled for OTA from OECD, *Trade of Commodities: Market Summaries*, Exports (1971, 1975-80).

Table 54.—Selected Telecommunications Contracts in Kuwait

Supplier country	Year	Supplier	Description	Amount (millions of dollars)
France	1980	CIT-Alcatel and Cables de Lyon	Coaxial cable linking Kuwait and Safwan, Iraq	5.0
United Kingdom	1981	Pye Ltd.	Complete communications system for Kuwait police	10.8
United Kingdom	1980	Pye Telecommunications	Telecommunications network maintenance	5.9
Sweden	1979	L. M. Ericsson	Telephone exchange extension; AXE type equipment	15.0
Kuwait	1980	Abdel-Aziz Abdel-Mohsin al-Rashid	Underground cable installation	7.0
Kuwait	1961	Kuwait Prefabricated Buildings Company	International telephone network extensions—Salmiya Exchange	17.5
Japan	1980	Nippon Electric Co.	Satellite ground station installation; repairs on NEC station completed in 1966	14.4
Japan	1980	Japanese Telecommunications Consulting and Engineering	Telephone network consultancy for management improvement, planning of repairs, preparation of specifications for international tenders, provision of training	7.4
Japan	1981	NEC	Install one central microwave station and six auxiliary ones. Design is by Kuwait Ministry of Communications	13.0
United States	1979	Ampex International	Supply of mobile television unit with auxiliary equipment	1.5

SOURCE: Compiled for OTA from selected issues of the *Middle East Economic Digest*.

mately 75 percent in telephone and telex, 17 percent in transmission, and 4 percent each in mobile radio and video and radio (see fig. 12). As figure 13 shows, in contrast to the situation in Saudi Arabia, Swedish firms have been dominant suppliers of telecommunication equipment in a number of categories.

Egypt

The number of telephone lines in Egypt in 1981 was estimated at 375,000 lines for between 400,000 and 500,000 telephones.[19] Approximately one-half of the telephones are residential and one-half commercial, yielding about 1.2 lines per 100 inhabitants, a very low ratio. Telephone service availability varies widely by geographical location, as large urban areas have a telephone density of 4.35 per 100 population while other areas have a density of 0.36 per 100 population.[20] In 1978 the waiting list of subscriber applications numbered 200,000 with only 48 percent of registered demand being met.[21] The telephone system is operated by the government and is 89.2 percent automatic.

By all reports, in recent years Egypt's telephone system has been generally antiquated (some parts dating back to 1929) and in poor repair. A 1978 master plan developed by Continental Telephone International of the United States recommended major rehabilitation of and extensions to the Egyptian system, upon which the government acted by awarding a major contract to a European consortium in 1980. Small exchanges in remote villages often consist of manual switchboards. These contrast with the larger, multiexchange, crossbar automatic switching equipment used in Cairo and Alexandria.

In 1979 an Alexandria exchange was renovated by CIT-Alcatel (France); their E-10 digital electronic exchange equipment supplied 10,000 lines. Ericsson of Sweden supplied 20,000 lines at Al-Mazha in Cairo in 1979. Extensive cable and microwave linkages (supplied by Raytheon of the United States) connect the smallest exchanges to Cairo, where most of the international traffic flows. Other international switchboards exist in Alexandria and Port Said. International calls are handled by two submarine cables with 480- and 230-channel capacities or via an Earth satellite station linked to the Intelsat Atlantic Ocean network.

For training purposes, CIT-Alcatel has installed an E-10 model exchange in the Arab Republic of Egypt National Telecommunications Organization (ARENTO) training center. Continental Telephone and Arthur D. Little are both being funded by the U.S. Agency for International Development (USAID) under its $200 million loan and grant program to ARENTO to supply managerial and technical advice.

Two telex exchanges operate in Cairo and Alexandria, and mobile telephone service has been established in the Cairo area. In addition, special microwave transmitters, using tropospheric scatter technology, have been established to facilitate communications between cities, oil terminals, gas plants, and offshore oil complexes.[22]

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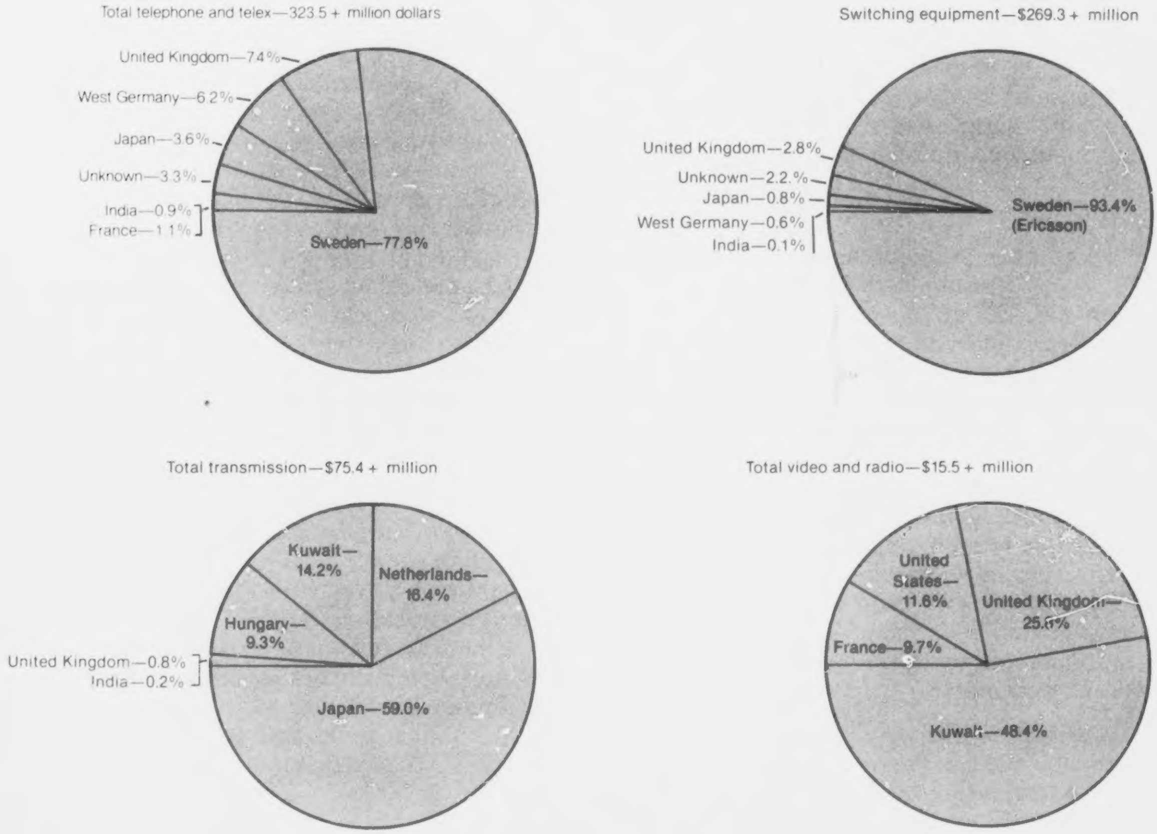
[19] U.S. Department of Commerce, "Marketing in Egypt," *Overseas Business Report*, 81-31, 1981.

[20] AT&T, op. cit., 1983.

[21] R. J. Saunders, J. J. Warford, and B. Wellenius, *Telecommunications and Economic Development*, JHU Press, published for The World Bank, July 1983.

[22] Tropospheric scatter technology involves use of radio frequency waves reflected off the troposphere and received at a distant station on Earth.

Figure 13.—Apparent Market Share—Kuwait, 1974-82



Radio and television broadcasting is well developed. A network of 24 radio transmitters have the capability of reaching the entire population. Fourteen transmitters have shortwave range and the 10 others are mediumwave. Between 6.6 million and 6.8 million radio receivers exist, according to 1979 estimates. Twenty-eight television transmission stations, some with color capability, reach 1.3 million receivers and 7 million people.[23]

The 1978 Continental Telephone study assessed the efficiency of the Egyptian communications network. Study participants found that only 23.9 percent of all calls dialed in Cairo were completed, emergency telephone numbers were frequently inoperable, and 50 percent of all service vehicles could not be used, owing to lack of spare parts. Moreover, the report concluded, Egypt's current problems could be attributed, in part, to the many different types of equipment in the system supplied by many different firms. Maintenance and interoperability problems could arise in the future, the report warned, if similar procurement strategies are followed in rehabilitating and expanding the system.

Attempts have been made recently in the Egyptian telecommunications sector to make its administration more efficient and cost effective. Outside consultants in the late 1970's stated that some of the major problems plaguing the Egyptian telecommunications operations stemmed from the inclusion of telecommunications in the public sector. As a result, 1) realistic rates and tariffs could not be set for telecommunications service or equipment installation, 2) employees could not be easily hired and fired, and 3) all money went into and came out of a central revenue fund, allowing for no fiscal autonomy. The consultants recommended that telecommunications be made an autonomous public entity, much like Egypt Air or the Suez Canal Authority.

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[23] *Overseas Business Report*, op. cit., 81-31, 1981.

Egypt's response was to pass law No. 153 in 1981, which established the National Organization for Wire and Wireless Telecommunication, whose shares are 100 percent owned by the government. The organization still reports to the Ministry of Communication but is otherwise autonomous. Although it is still too early to gauge the long-term effects of this change, tariffs and installation charges have recently risen to more realistic levels, and the new organization can retain its own earnings.[24]

Redundant labor will continue to be a problem, however; attrition has not eased the burden. The problem will become more severe when the electromechanical switches in the Egyptian system are converted to electronic switches, displacing many semiskilled workers.[25] For many reasons, major layoffs of these personnel are not expected.

By far, Egypt's telephone system is the least extensive of the six countries in this study. It reaches just over 1 of every 100 inhabitants. As for system usage, 1977 statistics show low international usage (an average of 1.1 international calls per subscriber in 1977) but high domestic use (an average of 50.0 national calls per subscriber that year).[26]

Imports of telecommunications equipment, parts, and accessories from OECD countries went from $11.9 million in 1971 to $180.4 million in 1980 (nominal dollars).[27] Telecommunications equipment comprised about one percent of the Egyptian budget and from 0.2 to 0.9 percent of world imports in telecommunications during these years.

As shown in table 55, France's position in the Egyptian telecommunications market has continued to grow. CIT-Alcatel and Thomson-CSF are major French firms, along with West German and Austrian companies, doing business in Egypt. Thomson-CSF won a major $1.8 billion contract to overhaul and expand the Egyptian telephone network. Great Britain and Sweden have also held sizable and fairly stable market shares.

The share held by U.S. firms has expanded substantially over the last decade, from 2.6 percent in 1971 to 17.9 percent in 1980. This was due partly to Egypt's improved relations with the United States. USAID grant and loan programs to rehabilitate the Cairo telephone system have provided major opportunities for introducing U.S. telecommunications firms into the Egyptian market.

Telephone and telex was the major area of investment in the telecommunications sector by Egypt from 1974 to 1982, accounting for 83.5 percent of total telecommunications expenditures. Transmission accounted for 11.7 percent, while video and radio, and mobile radio accounted for 4.5 percent and 0.2 percent, respectively. Of the over $2,300 million spent on telephone and telex, France had a 36 percent share; West Germany, 26 percent; Austria, 26 percent; Sweden, 5.5 percent; and the United States, 5 percent. Of the $324 million total spent by Egypt from 1974 to 1982 on transmission, U.S. firms dominated, with a 48 percent share. Those from West Germany had a 28 percent share; Japan, 10 percent; and Great Britain, 9 percent. The major shares of the video and radio expenditures of $123 million from 1974-82 went to firms from Great

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[24] Communication with industry expert, January 1984.

[25] AID intends to replace 170,000 lines presently with electromechanical switching to electronic switching. Ten to twenty inside-plant personnel per 10,000 lines are required to maintain old EMSS systems, while the new ESS systems require only one per 10,000 lines.

[26] ITU, op. cit., 1980.

[27] OECD *Trade of Commodities: Market Summaries, Exports,* 1971, 1975-80. See table 55.

Table 55.—Market Shares of Telecommunications Equipment Exports to Egypt From OECD Countries, 1971, 1975-80 (SITC 764 or 7249)

	United States	Japan	France	West Germany	Italy	Netherlands	United Kingdom	Sweden	Switzerland	Total exports (in 000 U.S. $)
1971	2.6	2.0	1.6	25.9	3.0	0.2	13.0	43.6	1.2	11,886
1975	2.7	17.8	26.3	8.5	0.7	0.4	15.2	21.9	2.2	59,479
1976	4.2	9.5	25.6	9.3	3.7	0.8	30.4	13.5	1.3	70,377
1977	14.4	2.5	23.7	10.0	0.6	0.5	31.6	12.9	1.8	97,262
1978	16.8	5.3	26.0	10.8	3.7	1.0	14.9	14.4	1.3	141,882
1979	14.4	9.3	36.3	8.6	3.2	1.0	11.2	12.1	0.4	183,286
1980	17.9	8.5	31.2	4.4	3.9	4.3	14.7	10.7	0.6	180,440

NOTE: Market shares calculated as value of exports reported by exporter as a percentage of total telecommunications exports to recipient reported by all OECD exporters.

SOURCE: Compiled for OTA from OECD, *Trade of Commodities: Market Summaries*, Exports (1971, 1975-80).

Britain (47 percent), Japan (29 percent), the United States (17 percent), and France (6 percent).

Algeria

The number of telephone lines in Algeria is approximately 606,000. The telephone system is government-run and involves only 63.1 percent automatic switching. About two-thirds of registered telephone demand has been met.[28] Twelve satellite ground stations have been in existence since 1979 for domestic telephone, telex, and television transmissions, connecting 14 Saharan towns with major population centers. An international Earth satellite station connects Algeria to the Atlantic Ocean Intelsat network. All major towns are connected to Algiers by telex, and several have their own international telex linkages.[29]

Television and radio broadcast centers are located in Algiers, Oran, and Constantine. Radio transmissions operate on medium and short wave, covering territory well beyond Algeria's borders. Microwave linkages with France ensure reception of European television broadcasts. By 1982, there were over 2 million radio receivers and 350,000 television receivers in the country.

Despite the rather limited coverage of the telephone system—3.3 telephone lines per 100 inhabitants—domestic usage by subscribers is relatively high, with an average of 31.2 domestic calls per subscriber in 1979. To deal with geographic difficulties in network transmission, Algeria opted for advanced satellite systems for part of its domestic operations. Algeria's telephone service is, however, frequently unreliable and slow, with long-distance service usually surpassing local service.

Algerian imports of telecommunications equipment, parts, and accessories peaked in 1976 at about $140 million. The 1976 figure represented slightly less than 3 percent of Algeria's total imports. In recent years these imports have made up about 1.5 percent of the total. Algeria represented from 0.3 (1970) to 1.7 (1976) percent of world imports of telecommunications equipment, parts, and accessories from 1970 to 1979.

During the 1970's, Algeria's national plans emphasized investment in heavy industry and development of natural gas resources. Associated development of a satisfactory telecommunications infrastructure was critical to achieving these investment goals. Algeria's extensive use of satellite technology for much of its domestic transmission network has facilitated communication linkages to the major population centers from natural gas fields, mining areas, and industrial production complexes across vast areas of sparsely populated desert.

Table 56 presents the market shares of telecommunications equipment exports to Algeria from OECD countries in 1971 and 1975-80. France has historically been a large supplier to Algeria. By 1980, French firms held 28 percent market share, much reduced from their 79 percent share in 1971. Algeria has attempted to diversify its technology purchases for political reasons and to improve its position in negotiating prices for its liquefied natural gas.[30]

U.S. firms have maintained their market share in the Algerian telecommunications area. This share has, however, fluctuated noticeably. Some observers believe that Algeria's support for the Palestinian movement and its nonalignment policy may serve to stimulate diversification of suppliers, rather than extensive purchases from U.S. firms.

Telephone and telex represented 68 percent of the Algerian telecommunications market from 1974 to 1982; transmission, 30 percent; and video and radio, 2 percent. Total telephone and telex expenditures during this period were approximately $456 million, with Spain winning 70 percent of this, Sweden winning a 27 percent share, and the United States, 2.5 per-

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[28] U.S. Department of Commerce, "Marketing in Algeria," *Overseas Business Report*, 82-07, 1982; AT&T, op. cit., 1983.

[29] H. Nelson (ed.), *Algeria: A Country Study* (Washington, D.C.: The American University, 1979).

[30] Martin Roth and Michael Frost, "Algeria Welcomes Japanese Export Drive," *Middle East Economic Digest*, Aug. 28, 1981, pp. 4-5.

Table 56.—Market Shares of Telecommunications Equipment Exports to Algeria From OECD Countries, 1971, 1975-80 (SITC 764 or 7249)

	United States	Japan	Belgium	Denmark	France	West Germany	Italy	United Kingdom	Spain	Sweden	Switzerland	Total exports (in 000 U.S. $)
1971	0.8	0.3	0.2	0.0	79.0	7.4	2.3	5.9	1.1	0.0	2.8	13,338
1975	5.4	3.0	0.3	0.3	37.7	15.4	1.0	4.3	14.5	16.1	1.7	120,062
1976	3.0	4.2	0.5	0.2	26.0	9.4	1.4	4.0	17.0	32.9	1.1	138,301
1977	9.2	8.7	2.7	0.3	22.8	10.0	2.3	6.6	13.1	22.7	1.6	94,908
1978	8.9	11.9	0.9	3.3	15.6	21.5	2.0	6.8	9.5	16.8	1.1	101,048
1979	8.2	3.1	1.1	2.3	18.0	22.3	1.5	5.8	20.0	7.3	8.7	128,918
1980	4.8	2.6	5.6	3.4	27.8	17.4	1.5	12.7	7.5	7.6	6.1	100,068

NOTE: Market shares calculated as value of exports reported by exporter as a percentage of total telecommunications exports to recipient reported by all OECD exporters.

SOURCE: Compiled for OTA from OECD, *Trade of Commodities: Market Summaries*, Exports (1971, 1975-80).

cent. Of the total transmission expenditures of $200 million from 1974 to 1982, Japan had a 53 percent share; France, 39 percent; and the United States, 6 percent.

Iraq

Statistics on Iraqi telecommunications are largely unavailable. The number of telephones in Iraq numbered approximately 320,000 in 1977, which amounts to 2.6 telephones per 100 inhabitants. Existing facilities include crossbar automatic telephone switching equipment with new exchanges installed in Baghdad, Nineveh, and Tamim, and microwave networks between major cities. Two Earth satellite stations exist at Dubail for use in international communications; they were built by Telspace, a subsidiary of CIT-Alcatel, of France.[31] A telex system located in Baghdad had 1,462 lines in 1980, but a contract has been awarded to triple this number. The number of radio receivers in the country is estimated at 2 million.

Based on rather scarce information, it appears that rapid progress was being made prior to the war with Iran to build the capacity of the Iraqi system. Major upsurges in government spending, begun in the mid-1970's, resulted in a near doubling of the number of telephones. Iraq has chosen crossbar switching and advanced digital systems, although usage in Iraq is still low—among the lowest of the six nations in this study.

Large-scale importation of telecommunications equipment by Iraq did not begin until 1975, when expenditures on OECD imports reached $65.5 million. Imports of telecommunications equipment, parts, and accessories from all suppliers represented over 3 percent of Iraq's total imports and over 1.1 percent of the total world imports of telecommunications equipment for these years.[32] Shrinking oil exports, beginning in 1982, and the prolonged war with Iran have, however, dampened further civilian expansion in the telecommunications area.

Table 57 lists the market shares of telecommunications equipment exports to Iraq from OECD countries in 1971 and 1975-80. With more than a 49 percent market share in 1980, France was dominant. Since the mid-1970's, Iraq has sought a leadership role among the Third World nonaligned nations and reduced its technology trade with the Soviet bloc countries. As a result, Japan, Britain, and the Netherlands made minor inroads into the market. U.S. firms won less than a 1 percent market share. Table 58 includes data on representative recent telecommunications contracts awarded by Iraq.

By telecommunications sector, telephone and telex have taken the major share of Iraqi expenditures (58 percent). Transmission has taken a 19 percent share; video and radio, 17 percent; and mobile radio, 6 percent. Of the total $1,170 million spent on telephone and telex between 1974 and 1982, Japan garnered 62 percent of the market; France, 13 percent; Yugoslavia, 11 percent; and Sweden, 2 percent.

Of the total transmission expenditures of $380 million during this time period, 45 percent went to Sweden, 25 percent to Japan, 11 percent to Italy, 7 percent to Great Britain, 6 percent to France, and 5 percent to unspecified suppliers. Swedish firms were particularly strong in wire and cable and land mobile radio, while Japan and Italy were both strong in microwave systems. Total video and radio expenditures from 1974-82 were over $340 million, with France having a 54 percent market share; Japan, 27 percent; and Switzerland, 8 percent. Japan was dominant in television (with 75 percent) and France was dominant in radio (84 percent). Total mobile radio accounted for $115 million in this time period; Sweden had 93 percent of the market and Japan and Great Britain had minor shares.

Iran

By 1979, Iran had 1,234,000 main telephone lines (95.8 percent automatic—92 percent EMSS, 3.8 percent ESS), which is approxi-

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[31] "Telecommunications, Electronics, and the Middle East—Special Report," *Middle East Economic Digest*, January 1981.

[32] *U.N. Yearbook of International Trade Statistics*, op. cit., 1982.

Table 57.—Market Shares of Telecommunications Equipment Exports to Iraq From OECD Countries, 1971, 1975-80 (SITC 764 or 7249)

	United States	Japan	Belgium	France	West Germany	Italy	Netherlands	United Kingdom	Sweden	Switzerland	Total exports (in 000 U.S. $)
1971	3.8	4.6	2.8	26.3	0.8	1.9	0.2	24.9	32.7	0.3	4,797
1975	2.4	26.9	1.6	19.4	7.7	3.3	0.4	22.7	6.7	5.2	65,513
1976	7.6	21.3	2.4	14.3	11.6	2.6	0.1	31.8	3.7	1.3	70,686
1977	2.0	9.9	0.8	51.5	4.6	0.6	0.1	22.6	3.6	1.5	76,131
1978	0.5	14.0	0.3	42.3	2.7	0.2	11.8	20.4	1.8	4.2	185,410
1979	0.4	13.4	1.0	43.4	4.1	0.7	14.1	9.6	4.8	6.3	193,784
1980	0.8	8.2	0.3	49.4	2.3	1.8	7.8	16.7	6.1	1.1	254,860

NOTE: Market shares calculated as value of exports reported by exporter as a percentage of total telecommunications exports to recipient reported by all OECD exporters.

SOURCE: Compiled for OTA from OECD, *Trade of Commodities: Market Summaries*, Exports (1971, 1975-80).

Table 58.—Selected Telecommunications Contracts in Iraq

Supplier country	Year	Supplier	Description	Amount (millions of dollars)
France	1981	Thomson-CSF	Provide 27 microwave telephone exchanges	152.0
France	1980	Thomson-CSF	Turnkey construction of telephone network	144.5
West Germany	1977	Siemens	Reinstallation and expansion of telephone exchange	0.6
Hungary	1977	Elektroimpex	Supply 2,500 color television sets	1.0
Italy	1982	Telettra	Set up two microwave systems	42.0
Japan	1979	Nippon Electric Co. and Mitsui Co.	Construct four computerized telecommunication and video control systems	19.1
Japan	1981	Sumitomo Construction Co.	Supply and install telecommunications facility	64.5
Japan	1979	Furukawa Electric Co.	Supply 17 telephone networks in Baghdad and surrounding areas, providing an additional 200,000 telephone lines	59.3
The Netherlands	1981	Philips	Install telephone network	11.1
Sweden	1981	SRA Communications	Install mobile telephone system	82.2
Sweden	1981	L. M. Ericsson	Supply and install telephone cables	166.7
United Kingdom......	1980	Cable & Wireless	Expand international exchange lines	3.9
Soviet Union.........	1981	NA	Construct telecommunications center	3.3
Yugoslavia	1980	Energoinvest	Construct two transmission lines	21.0

NA—not applicable.

SOURCE: Compiled for OTA from selected issues of the *Middle East Economic Digest*.

mately 3.4 lines per 100 inhabitants. Iran's system is completely government-run. Eighty-one percent of the lines are residential, and about one-half of them are located in Teheran. The 1979 waiting list for subscribers amounted to 750,000, meaning that only 62 percent of registered demand had been met. Data from 1976 indicate that 8.9 million national calls were made that year compared with 1.1 million international telephone calls.[33]

The major long-distance transmission networks in Iran employ microwave systems rather than multichannel cables, owing to the country's difficult terrain and other technical advantages of microwave systems. As of 1977, this microwave network consisted of four segments: 1) the CENTRO cross-country network, which traverses 2,300 kilometers and has 45 relay stations, beginning at Tabriz and serving Pom, Kashan, Isfahan, Nain, Yazd, Kerman, Bam, and Zahedan; 2) the Teheran-Assadabad large-capacity network; 3) the Isfahan-Shiraz network linked to Teheran; and 4) a nationwide microwave network encompassing six major routes, covering 3,560 kilometers, and having a capacity of 960 telephone channels. In addition, a ground satellite station is located at Assadabad near Hamadan to facilitate international traffic.

There are direct dial facilities to 27 foreign countries and 74 operator-assisted switchboards at the international telephone exchange. To deal with its vast geographic area, dispersed population, and rough terrain, Iran opted for microwave transmission in the mid-1960's and continued to expand this network nationwide. Despite rapid growth in exchange capacity during the 1970's, the number of lines per 100 inhabitants (3.4) is well below the world average of 10.5. Moreover, usage statistics by subscribers as of 1976 were among the lowest of the six countries in this study—an average of 1.6 international calls and 13 domestic calls per subscriber in 1976.

In 1979, Iran had over 2,980 telex lines and automatic computerized telex centers in several cities. One hundred and fifty cities were equipped with modern teletype and teleprinter systems, which replaced the old telegraph network. Under the Shah, three television channels and four radio networks were operated. Estimates of radio receiver ownership in 1976 were 4.3 million households; of television receivers, 1.6 million households.[34]

Iran developed its telecommunications infrastructure earlier than the other countries covered in this study. In its Fourth Development Plan (1968-72), Iran focused extensive investment funds on building its nationwide microwave networks, meeting existing demand for communication services and anticipating requirements for the future. During this period, between 3 and 6 percent of all Iranian imports involved telecommunications equipment, and Iran became a major world market for such items, acquiring 4.5 percent of world imports of telecommunications equipment in 1971. However, in 1972 and 1973, owing to a worsening balance of payments and capital shortage problems, investments in this sector declined.

The rapid oil price increases of 1973 and 1974 at the beginning of Iran's Fifth Development plan resulted in a major revision, doubling investment allocations. Expenditures on telecommunications projects again increased, reaching a peak in 1976 of $330.5 million. Budget deficits caused by lower oil revenues in 1975 and 1976 resulted in a leveling off of spending by the end of the plan period. Figures on telecommunications imports since the 1979 revolution are not available but, based on OECD export figures, such imports probably fell in the early 1980's to about one-quarter of the 1978 trade total.

During the 1970's, firms from the United States and West Germany shared the Iranian telecommunications market almost equally, about 25 percent each, as shown in table 59. The positions of firms from Japan, Italy, and the United Kingdom fluctuated rather widely from year to year but maintained an aver-

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[33] ITU, op. cit., 1980.

[34] M. Tehranian, "Communications Dependence and Dualism in Iran," *Intermediary*, vol. 10, No. 3, 1982, pp. 40-44.

Table 59.—Market Shares of Telecommunications Equipment Exports to Iran From OECD Countries, 1971, 1975-80 (SITC 764 or 7249)

	Canada	United States	Japan	Belgium	France	West Germany	Italy	Netherlands	United Kingdom	Switzerland	Total exports (in 000 U.S. $)
1971	6.5	15.2	21.9	1.2	3.9	22.1	19.7	0.3	5.6	2.5	91,859
1975	4.3	23.8	13.9	2.1	7.8	26.8	9.2	0.4	8.0	1.0	207,965
1976	6.9	38.0	7.7	0.4	5.7	24.7	7.4	0.2	6.3	1.2	330,461
1977	4.6	27.0	9.0	0.8	11.8	24.4	9.8	0.5	9.5	0.7	252,898
1978	0.9	22.6	12.7	0.7	7.5	21.1	9.1	9.4	13.2	1.8	315,323
1979	0.0	21.9	7.2	0.2	4.9	29.8	18.7	10.4	5.0	1.3	139,420
1980	0.0	0.0	17.3	0.2	2.0	32.6	32.7	1.4	9.5	2.1	75,069

NOTE: Market shares calculated as value of exports reported by exporter as a percentage of total telecommunications exports to recipient reported by all OECD exporters.

SOURCE: Compiled for OTA from OECD, *Trade of Commodities: Market Summaries*, Exports (1971, 1975-80).

age of only about 10 percent of the market each.

Market shares, as could be expected, have shifted since Iran's revolution. With the United States effectively out of the picture, Japan and Italy have been the beneficiaries, assuming 17.3 and 32.7 percent of the market, respectively, in 1980. West Germany strengthened its position to 32.6 percent of OECD telecommunications exports to Iran by 1980.

Telecommunications sector breakdowns in Iran between 1974 and 1982 were approximately 70 percent for telephone and telex, 27 percent for transmission, and 3 percent for video and radio. Supplier market share in each of these sectors has changed dramatically since the revolution. As a historic reference point, telephone and telex shares in 1974 were United States, 74 percent; Japan, 13 percent; Sweden, 6 percent; and the United Kingdom, 7 percent. U.S. firms had an 85 percent share of transmission equipment exports to Iran. For video and radio, France had a 77 percent share, the United Kingdom had 14 percent, and the United States had 8 percent.

Regional Telecommunications Development

The Middle East has focused attention on improving telecommunications among neighboring Arab countries. Several regional projects are under way, many having received their impetus from a telecommunications development plan for the Middle East drawn up by the International Telecommunication Union (ITU) in 1978.[35]

The largest regional project being planned is Arabsat which promises to bring significant benefits to countries of the region through improved communications. The system as planned will provide the capability for expanded and more efficient communications not only among countries in the Middle East, but also between them and other parts of the world. Therefore, on the one hand, the technology may be used to promote free flows of information. On the other hand, the benefits of the system will depend upon who controls it and how it is used. In light of the different approaches these countries have taken to television broadcasting and their different political stances, they will be challenged to produce joint broadcasts. Furthermore, decisions taken by leaders in each country about what types of broadcasts should be shown could limit information available to local viewers. Thus, the advanced technology embodied in Arabsat's planned system could be used to expand or restrict information flows, depending on how the broadcasting is handled.

The first Arabsat satellite is now scheduled for launch in November 1984 on a European Space Agency (ESA) Ariane launcher. The second was scheduled for launch by NASA's shuttle STS-25 Atlantis in May 1985.[36] A third will be kept as a spare. Each satellite will have an operational lifetime of 7 years.[37] The main ground control station will be in Riyadh, and an auxiliary station may be located near Tunis.

The concept of Arabsat grew out of a 1953 Arab League agreement to develop effective telecommunications links throughout the Middle East region. This agreement led to the creation of the Arab Telecommunications Union (ATU) in 1958 and its affiliated Arab Satellite Communications Organization (ASCO). ASCO is made up of five permanent members (Saudi Arabia, Libya, Iraq, Kuwait, Qatar) and four members elected by the general assembly for 2-year terms. The general assembly consists of the member countries' Posts and Telecommunications ministers and is the governing body of the organization. In 1969, the Arab States Broadcasting Union (ASBU) was formed.

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[35] The ITU is a specialized agency of the United Nations, comprising various fora which plan and administer the details of international telecommunications.

[36] "Space Shuttle Payloads and Experiments," STS Missions, 1 through 81, Rockwell International, December 1983. This will be the first flight for Atlantis.

[37] "Arabsat: A Giant Step for the Middle East," *Middle East Economic Digest*, Oct. 15, 1982, p. 84; "Ford Aerospace to Build Arabsat," *Aviation Week and Space Technology*, June 1, 1981, p. 24; *Middle East Economic Digest, Special Report—Telecommunications*, October 1983, p. 8; Ali Al-Mashat, "Data Communications Services in the Arabsat System," paper presented at the 2nd Gulf Computer Conference—Dubai, Dec. 14-15, 1982. To illustrate the potential that the system presents for controlling information, Arabsat has reportedly considered encrypting television broadcasts so as to ensure that they can be received only by appropriate members and that signals cannot be intercepted. See "Arabsat Satellite's Control Signals Will Be Encrypted," *Aviation Week and Space Technology*, May 21, 1984, pp. 176-177.

In 1972 several of the governments of the Middle East asked the United Nations Development Program (UNDP) for assistance in setting up a telecommunications network in the Middle East and the Mediterranean. The UNDP asked the ITU to study technical aspects of such a plan. In the first 5-year phase of the study, ITU drew up a master telecommunications plan for the region, compiled from detailed local surveys. It focused on creating and improving satellite, land, and submarine telecommunications links among the several countries (28 sponsoring governments approved the master plan in 1978—Iran, however, was not one of them). ITU estimated that the expenditures for just the international portions of the work would reach $3,000 million by 1990. Egypt, Iraq, Kuwait, Lebanon, Oman, Saudi Arabia, and the United Arab Emirates (UAE) will contribute 35 to 40 percent of the cost; UNDP will contribute a similar share, and the rest will come from non-Arab Mediterranean States.

In the second 5-year phase, ITU conducted subregional feasibility studies with an emphasis on improving communications in the Red Sea area by using microwave and submarine cables. The third phase will look at the ground network and the training of Arab nationals in telecommunications and broadcast engineering and management.[38] The master plan also suggested diversifying the telecommunications routing so as to increase reliability. Plans are also being made for an intra-Gulf coaxial cable linking the UAE, Qatar, Bahrain, and Saudi Arabia, with a later extension to Kuwait.

In 1976, Comsat, of the United States, was given a $100 million contract to provide technical consulting for the Arabsat program. Political issues delayed the program. The contracts for building the three satellites were awarded in May 1981 to Ford Aerospace (United States) and Aerospatiale (France). The final U.S. export license approval was not granted to Ford Aerospace until February 1982. Aerospatiale was reportedly named as the prime contractor because Ford was on the Arab boycott list. However, Ford received 59 percent of the total contract value ($79 of $134 million) and has the largest share of the work. Ford provides the antennas, propulsion units, power converters, communications subsystems, and altitude control systems.

Another $40 billion telecommunications master plan—MEDARABTEL—formulated by ITU and funded by the U.N. Development Program and participating countries, is now being implemented. In June 1982, Telettra (Italy) and Thomson-CSF (France) obtained an $18 million contract based on this plan for a microwave link between Saudi Arabia, North and South Yemen, Djibouti, and Somalia. The plan also includes extended telecommunications links with Europe and national and international transmission routes for radio and television broadcasting.

Other regional projects under way or planned in the Middle East include: 1) international sea navigation satellites; 2) trans-Gulf cable links; 3) an intercontinental submarine cable between Saudi Arabia, Singapore, Indonesia, and Sri Lanka, costing about $500 million; 4) a coaxial cable link between Algeria, Tunisia, Morocco, and Libya; 5) a coaxial cable link between Kuwait and Iraq in which CIT-Alcatel of France and BICC Telecommunications of Great Britain are involved; and 6) a telephone network being built by Philips of the Netherlands along a 1,200-kilometer highway linking Syria, Jordan, and Kuwait via Baghdad.

There are few discernible trends yet in technology trade for projects awarded for regional work. Arabsat, the ITU plan, and MEDARABTEL should create a great deal of business in expanding transmission networks, including Earth stations, submarine and coaxial cables, and microwave systems.

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[38] *Middle East Economic Digest*, Oct. 15, 1982; *Times of London*, Feb. 2, 1981.

Stress has been laid on expansion of the transmission network. By far the largest subsector of expansion has been satellite systems, with U.S. firms holding 76.5 percent of the market and French firms the remaining shares. In microwave systems, the Italian firm Telettra captured a 65.4 percent share. France's Thomson holds 34.6 percent of that market. Overall, in the transmission sector, which represented $283 million in expenditures from 1974 to 1982, the principal actors have been U.S. firms with 63.2 percent of the market, followed by French firms, with 23.9 percent.[39]

PERSPECTIVES OF RECIPIENT COUNTRIES AND FIRMS

Saudi Arabia

The rapid expansion of the Saudi telecommunications network has resulted in one of the most modern systems in the world. The Posts, Telegraphs, and Telecommunications Ministry (PTT) has not been averse to introducing advanced technologies—they have installed the world's first nationwide stored program control telephone system, used electronic digital switching, employed microwave and satellite transmission extensively, and experimented with fiber optic transmission. Given the size of the projects, the rapidity of implementation, and the sufficient funding of the program, it is likely that the firms, as well as the technologies involved will gain increased credibility in the international market.

The highest levels of expenditure in the most recent Saudi Arabian 5-year plan are for municipalities, electricity, education, civil aviation, health, roads, and desalinization. Telecommunications allocations are next on the list, representing about 3.7 percent of total expenditures, or $8.7 billion. Most of this amount is set aside for finishing ongoing projects, such as the Telephone Expansion Program and the Intra-Kingdom Microwave Project.

The telecommunications budget for the 5-year plan and the first three yearly budgets are presented in table 60. Expenditures have fluctuated on a yearly basis since the beginning of the plan and appear to be ahead of schedule. Between 1980 and 1982 alone, over $6.8 billion was allocated in yearly budgets. While the value of contract awards in telecommunications throughout the Middle East fell from 13.9 percent in 1982 to 4.2 percent in 1983, Saudi Arabia increased its purchases in this sector from $570 million in 1982 to $1,726 million in 1983.[40]

Demand for telecommunications equipment in Saudi Arabia is expected to continue to rise during the next 5 to 10 years as the telecommunications modernization program is completed. Government ministries and public corporations have accounted for about 85 percent of the purchases of equipment and services; of this, 80 percent is purchased by the PTT and the Ministry of Information. Other ministries are building new headquarters and have a need for large private automatic branch exchange (PABX) systems.

To conduct business with the Saudi Arabian government, a local agent and office is required. Joint ventures with Saudi interests are also encouraged. In evaluating responses to tenders, Saudi ministries reportedly give preference to 100 percent Saudi-owned firms over 51 percent Saudi-owned joint ventures. These firms are, in turn, favored over agent-represented foreign companies. In business, Saudi Arabian customs reportedly emphasize trust and personal contact as the basis for consummating business deals.

The largest purchaser in the private sector is ARAMCO, which operates an independent 27,000-line phone network, but demands will increase from other purchasers as hotels, uni-

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[39] ITA, op. cit., 1982.

[40] MEED Consultants, *Middle East Contracts: Directory and Analysis*, 1983 Second Half (London: Middle East Economic Digest, 1984).

Table 60.—Saudi Arabian Telecommunications Budgets As Compared to Total Budgets (in millions of U.S. dollars)

	1980-84 Plan	1979-80	1980-81	1981-82	1982-83
Total budget	$237,100	$48,500	$71,418	$86,868	$91,357
Telecommunications	$ 8,700	$ 1,429	$ 2,574	$ 2,154	$ 2,080
Video and Radio	NA	NA	NA	$ 459	$ 461
Percent of total	3.7	2.9	3.6	3.0	2.8

SOURCE: J. Shaw and D. Long, "Saudi Arabian Modernization: The Impact of Change on Stability," *The Washington Papers* (New York: Praeger, 1982); Edmund O'Sullivan, "Saudi Budget Shifts Emphasis From Infrastructure to Human Resources," *Middle East Economic Digest*, Apr. 30, 1982, pp. 16-18.

versities, airports, office buildings, and industrial facilities are completed.

Minimum requirements for all equipment are the norms recommended by the ITU's CCITT and CCIR.[41] U.S. modifications to these standards appear to be acceptable.[42] Private equipment connected to the public system must be approved by the PTT. For broadcasting equipment, important long-term supplier decisions are made when particular contracts are awarded, since European and American systems are often not compatible. Often, the detailed requirements for specific projects are drawn up by foreign consultants to the PTT. This is true in Saudi Arabia, where Arthur D. Little, Norconsult, Swedetel, ITU, and Preece, Cardew, and Rider have worked on the plans and requirements for large telecommunications programs and then served on the bid evaluation committees.[43]

The telecommunications subsector likely to receive the greatest attention over the next decade is that of telephone and telex. With goals to once again double phone capacity and to increase telex capability, large projects are likely to be awarded. Established suppliers who have won the confidence of Saudi Arabian officials and who have long experience in the market are in the best competitive positions. This means that Ericsson and Philips in the switching and user equipment area and Cable and Wireless for telex may benefit particularly from the projected expansion.

Growth in capacity often reveals hidden demand. So it is with subscriber usage of the expanded telephone system in Saudi Arabia. In 1977, with only 200,000 subscribers, the average number of international messages per subscriber was 5.8 calls. In 1980, with 700,000 lines in operation, each subscriber initiated over 24 international calls.

While there appears to be relatively high usage by current subscribers, the physical capacity of the network commissioned may exceed the expected demand through 1990 by about 500,000 lines. Saudi Arabia is, however, building now in anticipation of future demand, given projected rates of urbanization and industrial growth.

One indicator of the ability to absorb telecommunications technology is the number of employees per 10,000 phone lines. For a particular quality of service, the fewer persons required the more efficient the operations. In 1980, the total number of employees was given as 12,571, or 284 per 10,000 lines; an estimate for 1981 showed an improvement with 189 per 10,000 lines.[44] By comparision, AT&T used 102 employees per 10,000 lines in 1982.[45] These figures also compare favorably to the estimate of 140 employees per 10,000 digital lines for inside and outside plant operations.

Although the figures describe a Saudi system in transition, they show increasing efficiency by employees in operating and maintaining the equipment. The numbers are supported by other information on Saudi Telephone (Sauditel). While 62 percent of Sauditel employees were nationals in 1981, the proportion of Canadian supervisors was being reduced. The employment goal for the company is 80 percent Saudi nationals.[46] Nationals hold all public interface positions and many managerial roles. Saudi Arabian personnel aim to take over parts of the training program themselves.

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[41] The International Consultative Committee for Telegraph and Telephone (CCITT) and the International Consulting Committee for Radio (CCIR) are two of the ITU's largely autonomous permanent organizations.

[42] Intel-Trade, May 15, 1979.

[43] U.S. Embassy, Riyadh, *Market Research of Telecommunications Equipment*, February 1980.

[44] D. Fargo, "World Telecoms Tell Their Plans for Growth," *Telephony*, Sept. 24, 1979, pp. 88-111.

[45] AT&T, *Statistical Report*, AT&T, Basking Ridge, N.J., 1981.

Saudi nationals, once trained, reportedly have good ability to operate telecommunications equipment. While some with prior education in the United States are already oriented to Western technology, those who are products of the Saudi Arabian educational system have reportedly sometimes faced difficulties in moving from rote learning to programs centered around understanding causes and effects of operations.

Planned growth in telecommunications capacity takes into account anticipated growth in demand in conjunction with Saudi Arabia's rapidly growing population.[47] At the same time, the country has been experiencing a large influx of population into the cities since 1974. The average population growth rate in urban areas was 7.6 percent annually between 1970 and 1980. In comparison to the overall national rate of growth, this urbanization effect is extreme and may present future problems in that certain exchanges may be overcrowded while others are underutilized.

With an estimated 70 percent of its 2.5 million work force being foreign, Saudi Arabia set a goal of reducing the growth of the foreign work force. Projections indicate that the overall labor force may continue to grow through the year 2000.[48] Shortages exist within the managerial, professional, technical, and skilled labor categories, which all affect the labor situation in the telecommunications sector. Estimates suggest that non-Saudi labor encompasses more than one-half of the work force in these categories, vital to effective absorption of telecommunications technologies.[49]

Computer training programs have been established at Sauditel's data center and by the National Guard. Telecommunications and broadcasting training institutes have also been conducting programs in Riyadh and Jeddah since 1971. However, these programs have not attracted the number of trainees originally envisioned and have reportedly experienced high dropout rates.[50]

Most contracts for telecommunications equipment currently include training (in Eng-

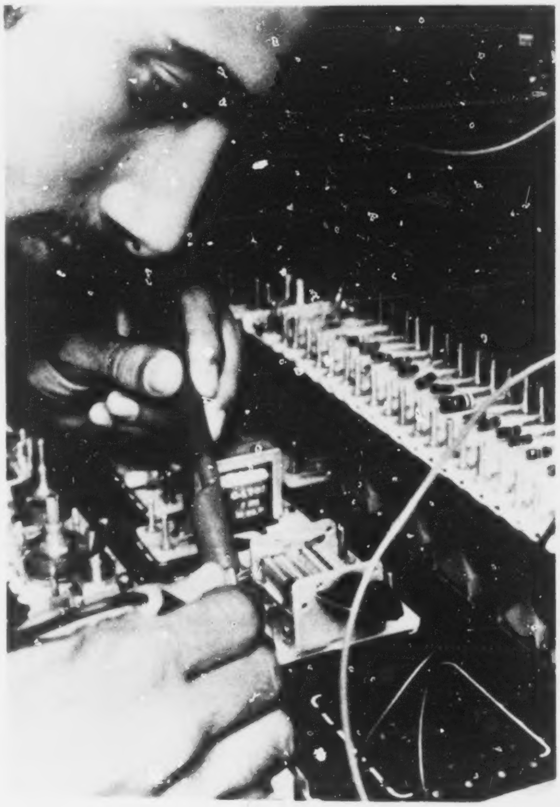

Photo credit: Aramco World Magazine

At ARAMCO's Ras Tanura Industrial Training Shop, a student tests electronic circuitry lish and Arabic), operations, and maintenance provisions. The training goal is often to bring nationals to a level of operational proficiency rather than preparing them to take over all aspects of maintenance, which is usually handled through joint ventures. This has been the case with the Intra-Kingdom Microwave Project, where Western Electric training in management and operations and maintenance was accomplished by Western Electric personnel for the first 12 months after installation and by Sartelco personnel (an Italian-Saudi joint venture) subsequently. Maintenance work is delegated to foreign contractors; thus dependence on suppliers continues. As discussed in the Saudi Arabian project profiles (included in app. 6A), U.S. firms bidding on the telephone expansion contract in 1978 had high cost estimates for operation and maintenance. These estimates may have been instrumental in loss of the contract.

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[46] "Riyadh Calling—Fast and Efficiently," *Middle East Economic Digest, Special Report on Saudi Arabia*, July 1981, p. 27.

[47] See ch. 4 for a discussion of various estimates of Saudi population.

[48] "Saudi Arabia—The Manpower Controversy," *Middle East Economic Digest*, Apr. 24, 1981, pp. 40-41.

[49] Industrial Studies and Development Center, *A Guide to Industrial Development in Saudi Arabia*, Riyadh, 1977.

[50] *Middle East Economic Digest—Special Report on Saudi Arabia*, July 1981; ITA, op. cit., 1982.

Saudi Arabia encourages foreign investment that results in domestic assembly plants and manufacturing facilities for import substitution. To date, there have been limited attempts at local manufacture in the telecommunications field. The Saudi Cable Company, a joint venture with Philips, plans a major expansion. Telephone Industries Co., Ltd., a joint venture with Ericsson, was established in 1976 to manufacture telephone equipment, apparatus and cable. It was licensed by Ericsson to produce cable, 50,000 lines of automatic exchange equipment, 40,000 lines of PABX systems, and 12,000 phone sets per year. By 1979, however, production had not begun. In addition, a Finnish company established a factory to produce TV tubes in 1977. Without plans for extensive local development of a telecommunications equipment manufacturing industry, Saudi Arabia will remain dependent on foreign sources.

Increased usage by the residential, business, and government sectors has revealed a pent-up demand for telecommunications equipment and services. One particular application of CCTV has had a major impact on education in the Kingdom. By custom, women have been segregated from men at all levels in the educational system. This has also extended to the required use of female instructors to teach female students. Because there have been shortages of female instructors, educational opportunities for women have been stymied. However, the introduction of CCTV into the classroom has enabled male instructors to teach women.

As the telecommunications network reached the small towns and villages in the Kingdom, it has provided local businessmen and traders with easy access to the national economy. The network thus has increased local employment, and brought increased prosperity to the outlying regions. Increases in telecommunications capabilities have also enabled the construction of refineries, industry, and exploration sites in remote areas of the country.

Expansion of both the civilian and military telecommunications networks in the Kingdom also has had national security implications. The government has acted to integrate these networks and thus improve its command and control capabilities. Litton Industries, of the United States, is participating in this project to integrate the networks.

While Saudi Arabia's telecommunications infrastructure has grown rapidly, capacity to absorb technology effectively has increased at a slower pace. Accounts of Sauditel accomplishments are impressive. Nevertheless, manpower shortages in managerial and skilled technical areas present continuing problems, despite efforts to establish training programs. Absence of a domestic telecommunications industry means that Saudi Arabia will be dependent on foreign suppliers into the foreseeable future. On the other hand, there is no doubt that Saudi Arabia can operate and maintain an efficient telecommunications system, because the country can afford to pay for operations and maintenance assistance.

Kuwait

Kuwait has aspirations to be an important regional and international financial center. A

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[51] The Economist Intelligence Unit, *Quarterly Economic Review*, London, April 1981.

reliable and advanced telecommunications network is a prerequisite. Kuwait's extensive international investments and foreign assistance programs also require modern telecommunications facilities. In addition, Kuwait Petroleum Company (KPC) has plans to establish itself as a major integrated international oil company. Such an operation requires extensive international communications to support management, production, and distribution. Advanced technology transfers will also enable the Kuwaiti government and business to establish links with databanks overseas.

The Ministry of Communications projects a doubling of telecommunications capacity between 1980 and 1985, as follows:[52]

	1980	*1985*	*1990*
Telephone capacity	269,000	381,000-500,000	1,100,000
Telephone subscribers	160,000	345,000	900,000
Telex capacity	6,000	15,000	na
Telex subscribers	2,400	5,500	7,500

A major goal is to rehabilitate the telephone system. Major repair expenses are being incurred for telephone cables; $1.38 billion has been allocated to replace damaged underground telephone cables with waterproof ones. Kuwait has imposed large fines on contractors who damage these cables during construction, but the fines have not resulted in an elimination of this problem.

Actual construction expenditures for telecommunications grew as follows:

1978	$ 72.2 million
1979	80.6 million
1980	79.1 million
1981	105.7 million
1982	152.4 million

During 1982-83, allocations by the PTT fell slightly from $212.9 million in 1981-82 to $201.6 million.[53] The Ministry of Communications is the major consumer of telecommunications equipment. Other major government purchasers are the Ministries of Defense and Public Health. Sales are by tender and are always carried out through a local agent.

Mid-range electronic PABX equipment (10 to 100 lines) can be only sold to the Communications Ministry, which then provides it to private users. Smaller and larger private exchanges can be sold directly to end-users. Most other equipment is marketed directly to private companies and individuals, such as the KPC, shipping agents, newspapers, and banks.

Kuwait continues to import the latest and most advanced telecommunications systems. Europe and Japan have come to dominate many key segments of this market, where American firms have lost bids owing to their higher prices.

The number of local telephone exchanges is expected to double over the next decade, as will the number of international trunk lines. Sophisticated subscriber equipment, including autodialing, and electronic PABX's, are popular among businesses. Over the next decade, Kuwait is planning to spend $1.5 billion on expansion of special telecommunications networks at ports and transportation centers and along highways.

In the transmission field, demand for satellite technology has been generated by the data transmission requirements of banks and financial institutions. Additional microwave linkages and uses for fiber optics will probably be identified over the next 10 years. Since there are no plans to develop a domestic telecommunications equipment manufacturing industry, Kuwait will continue to be dependent on imports into the foreseeable future.

In 1981, there were 347 telecommunications employees per 10,000 lines in Kuwait.[54] This compares with an estimated 140 employees usually required to operate and maintain digital equipment. It is also significantly higher than the employee-to-line ratio in Saudi Arabia and Iran.

Based on data reported by the ITU (1980), Kuwait's annual expenditures for maintenance and repair have been erratic. Through 1973, the costs were low—$3,000 to $6,000 per 1,000 main lines per year. The costs in 1974 and 1975 were very high in comparison—$75,000 per 1,000 main lines. Expenditures since then declined, but rose slightly again recently.

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[52] Kuwait Ministry of Communications, "Present and Future Telecommunications in Kuwait," March 1981.

[53] The Economist Intelligence Unit, *Quarterly Economic Review*, London, March 1982.

[54] AT&T Long Lines, op. cit., 1982.

These costs may be related to two factors. First, the use of many types of equipment and many suppliers during initial implementation of the telecommunications network is making it difficult to maintain sufficient inventories of spare parts and obtain replacements. Second, there have been problems in equipment maintenance. Overall, while there appears to be high demand for a variety of telecommunications services, the capacity of local Kuwaitis to operate and maintain the network efficiently has been limited.

With a high rate of population growth and a large expatriate population, Kuwait's demand on international trunk lines is likely to be high. Due to the large population shifts and changing needs of subscribers, it has been difficult to predict and match demand and exchange capacity. The waiting list for telephone subscribers has been large, fluctuating between one and five percent of the total population.

Kuwait faces manpower shortages that limit technology absorption in the short term. In the 1975 census, there were a total of 298,415 people classified as economically active. Of these, only 29 percent were Kuwaiti nationals. This situation has created a strong dependence on foreign contractors.

For example, a Japanese consortium of Nippon Telegraph and Telephone and Kokusai Denshin Denwa (KDD) planned, designed, and installed the telephone system between 1965 and 1975. Three years after the system was turned over to Kuwait, the Japanese were asked back to renovate, maintain, and operate the system, which had reportedly deteriorated. The new Japanese consortium, Japan Telecommunications Engineering and Consulting (JTEC), that accepted the job rejected a contract renewal offer. Citing payment withholdings and difficult working conditions, JTEC allowed another foreign contractor to take over the role of operator, maintainer, trainer, and consultant for the Kuwaiti PTT.[55]

The Kuwait Telecommunication Training Institute was established in 1966 to train nationals in maintenance, operation and supervision of telecommunications systems. Courses cover a broad range of subjects, including English, switching and transmission technologies, broadcasting and training methods. In response to rapid expansion of telecommunications services in Kuwait and limited numbers of Kuwaitis interested in the training, enrollment was recently expanded to a small number of non-Kuwaitis.[56]

In the construction field, Kuwaiti firms are apparently becoming large and capable, winning many civil works contracts. Except for Kuwaiti trading companies that procure telecommunications equipment from foreign suppliers for the government, local firms are often not capable of fully absorbing the advanced technology installed.

Egypt

As its telecommunications facility is modernized and as Beirut has been the site of prolonged civil war, Cairo is likely to emerge as a major regional commercial center. Already, it is serving as a cultural center in the Arab world, exporting television and radio programs from its large broadcast studios.

Radio and microwave transmission facilities have improved communications for Egyptian oil companies between headquarters, oil wells, and refineries. Improved and more reliable transmission will probably create a new computer and data-processing industry, producing a demand for indigenous computer programers. The increased investment in the telecommunications network may help slow the outflow of technically trained and experienced workers from Egypt to elsewhere in the Arab world.

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[55] "Japan Telecommunications Engineering and Consulting (JTEC)—Kuwait's Reluctant Partner," *Middle East Economic Digest*, Oct. 15, 1982, p. 90.

[56] Telecommunications Training Institute, *Prospectus—Telecommunications Training Institute*, TTI, Safat, Kuwait, 1983.

Satellite links also have enabled more reliable and timely communications between the Foreign Ministry and Egyptian embassies abroad. Moreover, Egypt has been a major purchaser of military communications equipment from France and other suppliers. The British, for instance, have a joint venture in Egypt to manufacture military radio products.

The 1978 master plan for telecommunications developed by Continental Telephone International has apparently been adopted as Egypt's official 20-year plan. That plan and the initial budget figures for the 1980-84 development plan in the transport and communications sector allocated $2.4 billion to project investments over a 5-year period.[57]

The basic goals are to: 1) increase the number of telephone lines from 700,000 to 1.6 million by 1985, 3.0 million by 1990, and 4.5 million by 2000; 2) attain a telephone line density of 3.7 per 100 inhabitants by 1985; 3) install 12,000 new telex lines by 1985 and 26,000 by 1990; 4) install new and replacement coaxial cable linkages between major cities, submarine cable between Egypt and Saudi Arabia, and microwave linkages between Upper and Lower Egypt and to the Sinai; and 5) establish new broadcasting stations and towers and renovate or replace existing equipment.

Eighty percent of all contracts in this field are with the public sector—ARENTO (Arab Republic of Egypt National Telecommunications Organization), ministries, or 11 other public-sector organizations. In the public sector, agents are required to represent foreign firms, financing is essential, and political clout is reportedly useful.

The private sector, in comparison, has greater access to funds and can buy directly from suppliers. In fact, one source indicates that the key factor in making a successful sale to the government is the availability of favorable financing; the technology chosen is a direct result of the best financial package.[58] Decisions of convenience rather than technological planning may have resulted in the purchase of a large variety of equipment types that must now be made compatible.

The standard for electrical current in Egypt is 220 volts, which benefits European suppliers over American firms. There is no formal statement concerning telecommunications standards; ARENTO and its contractors have developed them as the need arose.[59]

The estimated cost for the 4.5 million new telephone lines by the year 2000 is $17.4 billion. Feasibility of the telecommunications plan largely rests on the availability of financing from suppliers, donor countries, and international organizations. Even if the projected 700,000 new telephone lines are successfully completed by 1985, there will still be an estimated shortfall of 400,000 lines. This pent-up demand helps explain the likely focus of requirements over the next 10 years. Telephone and telex equipment will be the largest sector for expansion, mostly in switching and subscriber equipment. While most of the current exchanges are of the crossbar type, fully electronic digital equipment is expected to be used increasingly.

There is a shortage of telex capacity in Cairo as a result of increases in the number of businesses opening offices there. ARENTO is planning to spend $17.2 million to install additional telex exchanges, telex traffic is expected to quadruple by the year 2000, placing further strain on capacity.

The transmission network is in great need of renovation and replacement. The major market will be in coaxial cable and carrier trunks. Enhancements to microwave systems and high-frequency radio are secondary markets. In addition, as digital transmission takes over there will be a developing market for Time Division Multiplex (TDM) equipment.

ARENTO is forced to employ more personnel than needed in order to help alleviate the country's high unemployment. This has led to underemployment, problems in supervision, and a resulting poor quality of workmanship and service.

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[57] Charles Richards, "Egypt Embarks on Crash Modernization Program," *Middle East Economic Digest*, Oct. 15, 1982, p. 87.

[58] U.S. Department of Commerce, *Communications Equipment in the Arab Republic of Egypt*, Washington, D.C., 1980.

[59] Ibid.

Annual expenditures for maintenance and repair of the telephone service slowly escalated from a 1970 level of $62,651 per 1,000 main lines to $81,580 per 1,000 main lines in 1976 (in constant 1979 dollars). This gradual response to an apparently rapid deterioration of the network was a major contributor to poor service. In 1977, major increases to the maintenance and repair budget—reaching $146,961 per 1,000 main lines—signalled the beginning of of the "quick fix" approach to restoring quality service.[60]

The major domestic source of telecommunications equipment is the Telephone Apparatus Company, which is government-owned. Previously a joint venture with Ericsson and now under license to that company, this facility produces 35,000 lines of crossbar exchanges, 7,000 lines of PABX systems, and 35,000 phone sets per year. Annual sales in 1978-79 were $12.9 million. The factory appears to be well managed. It produces many of the technical components and is not merely a subassembly operation. However, because it is a state-owned factory, pay is on a low, government scale, and good technical staff are reportedly lost to private enterprise. Egypt also has a radio and TV production plant. The labor force at this facility totals 200 and is trained in manufacturing, management, quality assurance, and design.

Among Middle Eastern countries, Egypt has a comparatively large population and a fairly high percentage of its population aged 20-24 enrolled in higher education—15 percent in 1978. In 1978-79, there were 11,117 graduates and 72,306 students enrolled in engineering, science, technology, and electronic curricula in Egyptian universities. These numbers increased rapidly during the 1970's, which suggests that a growing base of technically qualified manpower will be emerging shortly. One problem will be to keep them employed within Egypt.

Egyptian fitters and technicians are reportedly capable. But at the same time, these skilled laborers go abroad, depriving Egypt of experienced technicians. As a result, there is a lack of experienced skilled workers to operate and maintain the telecommunications network. Much of the existing network is maintained by foreign contractors.

Under USAID funding, Continental Telephone and Arthur D. Little are providing extensive training in craft skills such as telephone installation and cable splicing. They are also attempting to transfer broader technical knowledge to the more advanced employees. Training sessions are held at ARENTO's Telecommunication Training and Research Institute in Cairo. The training, which is provided in both English and Arabic, includes formal classroom as well as on-the-job learning experience.

Thomson-CSF is commissioned to train Egyptian technical staff to take over operation of the enhanced network within a 3-year period. Apart from this training, the Ministry of Interior has established a separate institute of telecommunications training. This ministry is responsible for fire, police, security, emergency services, and traffic functions—and thus has very special communications needs. Training at all levels—from technician upward and from telex machine repair to microwave circuitry design—is conducted.

Although skilled manpower shortages represent one major constraint to absorption, it may be possible to overcome this problem in the short term by retaining in-country skilled technicians who are emerging from the universities and training programs. The most difficult constraint to absorption, however, is the availability of sufficient capital to pursue the planned development of the telecommunications network.

Algeria

The planned expansion of the telephone and telex networks has enabled Algerian national planners to begin to address the needs of other industries. The growth of LNG production, liquefaction plants, and export markets will require increased domestic coordination and international linkages through telecommunications. Planners are also encouraging small-to-medium private enterprise and decentralizing industry from Algiers and the coastal plain; both efforts will entail better telecommunications facilities.

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[60] ITU, op. cit., 1980.

The expansion of the telecommunications network is likely to integrate the rural areas with the political and social mainstream of the nation. At the same time, the urban population explosion and planned increase in housing construction will put greater demands on the capacity of the telecommunications network.

The 1980-84 Algerian development plan allocates $2.5 billion, or 2.5 percent of total allocations, to telecommunications. Overall, one-quarter of the funds are devoted to complete projects currently under way, and the remainder to new projects. The breakdown of projected investment is (in millions of U.S. $):[61]

Switching	$ 757.7
Transmission	453.0
Buildings	363.2
Network plant	342.3
Improving quality of service	68.9
Support equipment	48.0
Other services	54.3
Radio and TV	400.0
Total	$2,487.4

As occurred with previous development plans, it has been impossible to spend the allocated plan funds within the expected time frame, owing to manpower shortages, construction delays, and insufficient installation capability.

Very little, if any, telecommunications equipment or services are purchased by private industry in Algeria. National ministries and state-owned companies do all the tendering, selection, and procurement, even for private concerns. The Posts, Telegraphs, and Telecommunications Ministry (PTT) is responsible for about 75 percent of purchases for the public networks; the Radio and Television Agency procures radio and video equipment; Sonatite, a state company, obtains equipment for private end-users (PABX's and phone sets); and mobile radio equipment is purchased by each ministry and national company individually. Standards for Algerian equipment are based on French, and therefore, ITU norms.

The Algerians are committed to conventional technologies—analog transmission and crossbar switching produced locally. Thus, Algeria's approach is quite different from that taken by Saudi Arabia and Kuwait, and more similiar to that of Egypt. Price is usually the most important criterion in awarding a telecommunications contract. In fact, most ministries and network companies are mandated by law to grant contracts only to the lowest bidder. Technical competence of the contractor and the reliability of equipment, as demonstrated by installations elsewhere, are also important decision factors. Since the Algerians have also been trying to rid themselves of an overdependence on French imports, non-French suppliers have been in a good position.

The largest expansion will probably be in switching and transmission, especially in light of plans to increase line density in urban areas and expansion to rural areas. Firms from Sweden, Spain, and France are likely to be predominant in the switching and subscriber equipment areas. Japan is likely to become dominant in the transmission area, since it supplied cable and microwave networks and is a front runner in supply of additional Earth stations.

A substantial amount of telecommunications equipment is currently being produced locally. While these plants may have been designed to produce the equipment from start to finish, most are assembling components still imported from Spain or the United States. Moreover, these plants are not yet up to full-capacity production and probably will not be until late in this decade. Therefore, there is still an import market for crossbar and subscriber equipment, cable, and TV and radio receivers.

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[61] Michael Frost, "Algeria: Telecommunications Expansion Under Way," *Middle East Economic Digest*, Apr. 24, 1981, p. 6; Konsulterna, "The Market for Communications Equipment and Systems—Algeria," U.S. Department of Commerce, August 1981.

There are three major local sources of telecommunications equipment production. The factory built by Standard Electrica-ITT (Spain) at Tlemcen in 1975 was designed to produce 100,000 lines of public telephone crossbar switching equipment, 20,000 lines of PABX switches, and 140,000 phone sets per year. The plant is only today beginning to reach this capacity level, because of employee turnover and the difficulty in training employees. Currently, the factory is assembling components imported from Standard Electrica in Spain; but it was originally designed to enable complete local manufacture.

Two cable factories have a capacity of 10,000 tons per year of multipair pressurized cable. Production can be shifted to jelly filled cable as well. The national company in charge of these factories is contemplating microwave and multiplex production later in the decade.

Another facility, built by General Telephone & Electronics (GTE) (U.S.) under a 1976 contract, is a TV and electrical production plant that is still being supplied by GTE. It has the capacity to produce 130,000 TV sets and 400,000 radio receivers annually. At capacity levels, the plant was designed to have a staff of 4,000 Algerians.

By 1990, it is likely that local production will be able to handle a substantial portion of the demand. By one estimate, local manufacture will be able to meet 55 percent of domestic switching needs and 90 percent of the multipair cable requirements.[62]

The telecommunications network is extensively used by subscribers. In 1979, each subscriber made an average of 31.2 domestic calls. This compares favorably with an average of 13.0 domestic calls in Iran and 15.5 in Iraq.

Algeria has a high average net growth rate of population—2.9 percent per year. Estimated at 18.9 million in 1980, its population by 1990 should grow to 25.2 million. This places a continuing pressure on the telecommunications network capacity. For example, the waiting list for telephone subscribers has grown at an average annual rate of 41.8 percent over the past decade. The current push to provide more capacity will narrow the gap between supply and demand, but if Algeria fails to continue to expand the phone system beyond the 1985 goals, the result may be a low density of 3 phone lines per 100 inhabitants in 1990.

Another pressure on the network is the very rapid population growth of urban areas—almost twice the projected overall growth rate at 5.7 percent per year. Capacity in already crowded urban exchanges will have to be expanded at a much faster pace than in rural areas.

One goal of the current plan is to decrease the extent of foreign assistance required in manufacturing and installing additional capacity. To that end, the three local manufacturing plants have been designed to be self-sufficient. National companies are also taking charge of installing exchanges and transmission equipment. However, attracting, training, and maintaining sufficient manpower has been a problem in both production and installation, resulting in the need for continued foreign technical assistance into the foreseeable future.

Although technology transfer is a national goal, the capacity of local personnel to carry out this goal has been questioned by some U.S. firms that have worked in Algeria. It is their opinion that while some Algerian trainees are conscientious in learning how to operate and maintain their segment of the telecommunications network, a large proportion is unmotivated to do so and unable to handle the technology efficiently even after extensive training. Moreover, attempts to develop higher-level training in telecommunications technology with the university in Algiers and the establishment of technical training schools were unsuccessful, owing to government funding cuts.

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[62] Konsulterna, ibid.

Exacerbating this manpower problem, the modern analog telecommunications technology being installed in Algeria is more labor-intensive than digital technology. Given a conservative rule of thumb of 150 inside and outside plant personnel per 10,000 analog lines, Algeria will require a minimum of 15,000 telephone employees operating and maintaining a 1-million-line network by 1990. Judging from manpower requirements for telecommunications systems elsewhere, approximately 9 percent of the employees will need college degrees in engineering and management. Eighteen percent will have to be technical school graduates in electronics to serve as technicians in switching centers. Sixty-six percent will need some electrical repair training to serve as outside plant installers and repairers. The remaining 7 percent will have to be literate to serve as operators and clerks.

Of the six countries in this study, Algeria has the lowest percentage of the relevant age group enrolled in higher education (4 percent) or in secondary school (31 percent). These statistics, plus the large proportion of the economically active population working abroad in France, suggest that Algeria may face the constraint of insufficient skilled manpower to fully absorb the telecommunications technology it is purchasing. As a result, Algeria will probably have to depend significantly on foreign technical help beyond 1990.

If current trends and plans for development and export of liquid natural gas materialize, the necessary capital for telecommunications efforts should be available. However, there is insufficient high-level management and technical personnel to operate the telecommunications factories and the growing network. Training efforts for technician-level telecommunications personnel must compete with requirements of other industrial establishments for available manpower. These training efforts are, however, critical to more effective utilization of telecommunications technologies.

Iraq

Iraq's telecommunications network has brought with it efforts to expand the technically trained work force, but in the short term increased dependence on foreign technical support has resulted. Moreover, in purchasing advanced computer-based technology, Iraq may limit maintenance problems now, but expand foreign dependence later, if sophisticated training is not pursued. Iraq's motivation to expand its telecommunications networks is also, in part, to serve its requirements for improved military preparedness. At present, with oil revenues reduced and the war with Iran continuing, projects in the telecommunications field are putting an increased strain on Iraq's balance of trade.

Iraq planned 525 new projects to develop the telecommunications infrastructure in the current 5-year plan. Among the goals were:[63]

1. Increase telephone capacity to 1 million phone lines by 1985 and to 1.8 million by 1990.
2. Increase phone density to between 7 and 10 phones per 100 inhabitants by 1985.
3. Increase the number of telex subscribers to 6,000 by 1985 and to 10,000-18,000 by 1990.

There is an absence of information on specific objectives in the telecommunications area and no cost breakdowns of planned development in Iraq's 5-year plan. As a standard for comparison, the previous 5-year plan allocated $1 billion to telecommunications programs. It was estimated that almost one-half of these funds were used to establish military communications networks.

Major government contracts are usually put out to tender for international competition. Sales in telecommunications equipment and services are often made to ministries directly or to state trading organizations. Local representation for foreign firms is often useful in enhancing sales.

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[63] Intel-Trade, Mar. 30, 1979; ITU, op. cit., 1978. MEED Consultants, op. cit., p. 7.

Over the long term, Iraq intends to expand its telecommunications network in both rural and urban areas, using the latest digital transmission systems. An east-west microwave system has been contemplated to support international trade of food and agricultural products. Other areas likely eventually to see increased demand are PABX systems, mobile radio telephone networks and data communications networks, for state organizations.

West European firms from France, Great Britain, and Sweden already dominate in many sectors. Japanese companies tend to be predominant in switching and wireless networks. It is likely that they will continue their major presence in the Iraqi telecommunications market. The Eastern bloc—Hungary and the Soviet Union—have made only minor inroads in this market. U.S. firms, likewise, have had a very limited presence.

International usage has been high and this has strained the capacity of the network. International communications traffic had grown at 30 percent annually. This was probably a consequence of the growth in business and exports as well as the large number of foreign workers in Iraq.

There are several factories devoted to electronics and telecommunications equipment. A semiprivate company has the capacity to produce 50,000 telephone sets annually. A public-sector factory producing telephone wire was scheduled to be commissioned in the early 1980's. A contract was signed in mid-1981 with Thomson-CSF (France) to establish an electronics manufacturing facility, and consideration was being given to developing indigenous production of TV and radio receivers. However, given startup times for new facilities and current capacity limited to component assembly, dependence on foreign telecommunications equipment imports is expected to continue at a high level.

Although figures on Iraq's manpower situation are not available, large numbers of foreign workers have built factories and infrastructure and operated and maintained Iraq's telecommunications system.[64] In part, Iraq sees purchase of advanced technology as one way of offsetting its deficiency of skilled manpower. Most contracts for equipment stipulate that operation and maintenance of that equipment by foreign contractors must include training that supports indigeneous absorption goals.

Iraq's plans for expansion of the telecommunications system have been delayed by the war with Iran. By far the largest share ($6.4 billion of $7.2 billion) of contracts awarded in 1983 were in the defense sector. Although authoritative information is not available, it appears that Iraq's telecommunication expansion has been concentrated primarily in the military sector in recent months.

Iran

Expansion of television broadcasting (reaching more than 65 percent of the population) and other mass communication vehicles has been a major instrument of political mobilization in Iran, used to discredit the Shah and then to legitimize the new regime.[65] Telecommunications have also been used by the Islamic regime to build support. The regime's priorities suggest that future investments in telecommunications will be focused primarily on consolidating military positions and ensuring readiness.

Early in 1982, a 20-year development plan was approved and in September 1982 a new 5-year plan was implemented in Iran. In these documents, the regime stated its wish to avoid the degree of dependence on foreign suppliers that the country experienced under the Shah. The principal objective of the current plan is economic self-sufficiency. Staple items and strategic and intermediate goods must be produced domestically.

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[64] Jonathan Crusoe, "Iraq's Spending Slowdown Disappoints Contractors," *Middle East Economic Digest*, Feb. 19, 1982, p. 10.

[65] Tehranian, op. cit., 1982.

The PTT Ministry has selected sectors that will receive enhanced telecommunications networks. In order of priority they are: 1) security and defense forces, 2) "voice and vision broadcasting," 3) government institutions, 4) productive and agricultural sectors, 5) villages, 6) trade and commerce, and 7) households.[66] In addition, goals have been established to develop telecommunications facilities for all villages of 1,000 persons or more by 1987 and all smaller villages by 1997. Some expansion and repair work is apparently proceeding. Approximately 43,000 new telephone lines are planned for installation in Teheran, Gilan province, and Rasht.

Reportedly, $8.3 million has been spent through June 1982 on reconstruction and renovation of telecommunications facilities and microwave equipment. The telecommunications budget for 1982-83 was set at $27.2 million. Moreover, an amendment to the 1982-83 budget included $112 million for completion of several projects. In comparison, planned investments in telecommunications under the Shah amounted to $380 million (1978-83), $546 million (1983-88), and $913 million (1988-93). Given the sketchy information available on current plans and budgets, it is difficult to assess the likelihood that the goals will be vigorously pursued.

Based on 1981 figures, Iran had a fairly low ratio of telecommunications employees (255) per 10,000 lines. This suggests a rather efficient operation.[67]

Prior to the overthrow of the Shah, two domestic manufacturing plants were producing telecommunications equipment, primarily telephone sets. One factory was a joint venture with Siemens, and the other was under a licensing agreement from another German firm. It is unknown whether these plants are still in operation. Iran thus developed a limited level of self-sufficiency in equipment production.

Reported shortages of telecommunications equipment and spare parts in Iran since the revolution have encouraged expansion of local production and importation of materials from friendly countries. Although some requirements are being satisfied by domestic sources of supply, the domestic cable manufacturing facility reportedly has had difficulties meeting demand.[68] Given Iran's desire for greater self-sufficiency, it is likely that it will attempt to increase indigenous production of telecommunications equipment and will probably draw upon West German, Italian, and Japanese expertise to expand its capability.

Iran's population is growing at an average annual net rate of 2.3 percent. Extrapolating to 1990, Iran's population may be 48.7 million. If previous trends continue, population growth in urban areas will increase at a rate of over 4 percent annually. These factors will serve to put more stress on the capacity of the existing system. As an indicator of this push on demand, waiting list statistics for telephone lines have increased exponentially between 1971 and 1979—from 133,559 persons (0.5 percent of the 1971 population) to 750,000 persons (2.1 percent of the 1979 population).[69]

Iran made strides in addressing the problem of shortages of skilled labor in the 1970's. Statistics demonstrate that between 1969 and 1974, the number of engineering students receiving higher education in Iran more than doubled. In addition, the contract with American Bell International, Inc., focused in part on developing full self-sufficiency in telecommunications training by 1985.[70] Iranian trainees who went through the Bell training program exhibited a clear ability to master hardware operation because the training was practical, technical, and hands-on. Maintenance and administrative training were more difficult for trainees to grasp. Several Iranians who finished the courses successfully became instructors for their colleagues.

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[66] *Akhbar* (Iranian newspaper—English translation), Sept. 27, 1982; Oct. 9, 1982.

[67] AT&T Long Lines, op. cit., 1982.

[68] ITA, op. cit., 1982.

[69] ITU, op. cit., 1980.

[70] *Telecommunications*, August 1979.

On the negative side, some of the Bell training courses experienced a dropout rate of close to 50 percent. Moreover, many of the management skills viewed as essential to efficient operations were found to be too Western-bound and culturally alien. These topics included team approaches to problem solving, communications skills, and recordkeeping skills.

Like Iraq, Iran's telecommunications expansion depends on the course of the war. In 1983, however, Iran reportedly awarded $20 million in contracts in this sector, in comparison to $1.5 million reported for Iraq.[71]

Several common themes have emerged in the analysis of these six nations that serve to enhance or constrain indigenous capabilities to absorb telecommunications technology. These are described below.

Factors that Facilitate Absorption

National Objectives to Reduce Dependence on Foreign Suppliers.—Almost all of the countries in this study maintain as a formal national goal reducing dependence on foreign suppliers. Algeria, Saudi Arabia and Iran have set conscious goals to increase self-sufficiency in industrial production and in telecommunications in particular. These objectives have been generally implemented through major training programs. This was true with the American Bell training contract in Iran before the revolution and the Bell Canada training contract in Saudi Arabia.

In some cases—Saudi Arabia, Kuwait, and Iraq, in particular—these goals are critical for reducing the presence of large foreign work forces in-country. Saudi Arabia has established goals to enable rapid transfer of technical operations to the indigenous labor force. This has involved major investments in training of administrative and management methods and technical skills. Saudi Arabia has emphasized programs to improve productivity among trained nationals as a way of reducing the resident foreign work force.

National Security.—Iraq and Iran have expressed special interest in application of telecommunications technology to improve military readiness. Moreover, each of the six countries has made large investments in sophisticated military communications systems over the past 10 years. Undoubtedly, these acquisitions and the training of nationals in the military services to operate and maintain the equipment have contributed to improvements in civilian capabilities to absorb the technology.

National Objectives to Build Infrastructure.—Each of these countries has taken the opportunity, afforded by the rapid increase in oil revenues during the 1970's, to rebuild a decaying infrastructure or to develop a base. They realize that without modern transportation and communication networks, electric power grids and other basic utilities, and a network of health, education, and social services they will not be able to build and develop the productive sectors of their economies. In this context, telecommunications systems have been seen as essential parts of the national infrastructure. Countries such as Saudi Arabia have seriously supported these commitments, backed them with sufficient funds, and avoided bureaucratic constraints.

Indigenous Production.—Domestic production of telecommunications equipment reduces foreign imports required. While production in each of these countries is limited and often consists of only component assembly plants, it provides a stable base of training in technical skills. Domestic manufacturing has taken various forms. Local firms have in some instances operated under license to a major supplier, participated in joint venture with a Western firm, or been involved in technical cooperation with a foreign corporation. In some cases, Algeria and Egypt for instance, domestic plants have the capacity to manufacture the components.

At the same time, because these Middle Eastern countries invest very little in technical research and development, they are often constrained by the technology they originally select for manufacture. Hence, most domestic production in the Middle East involves electromechanical analog switching and rotary telephone instruments. Ironically, private industry and business that can afford more sophisticated equipment may import electronic digital PABX's and push button phones from foreign suppliers, bypassing domestic producers entirely, as occurred in Egypt.

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[71] MEED Consultants, op. cit., 1984.

Decision To Stay With Conventional Technology.—Another factor that enhances the capacity to absorb technology is continuity in programs, needed to ensure compatibility of technology. If a country has made a clear decision to adopt established technology as the standard nationwide and does not sway from that decision by importing experimental equipment, absorption will be enhanced. By using one type of technology, training is simplified and focused. Algeria, for example, has chosen to stay with conventional electromechanical equipment because it is a known quantity, has been proven to be effective, and is easier to master for trainees with limited electrical background.

Synergy With Other Industries.—Absorption of technology is fostered by a continuing demand for improved services from a growing user community. The growth of domestic and export industries in these countries, and an increase in housing construction, have synergistic effects on the growth of telecommunications networks and on the indigenous capacity to operate and maintain them.

Factors That Constrain Absorption

Manpower Shortages.—Saudi Arabia and Kuwait presently have work forces that lack

Photo credit: Saudi Arabian Ministry of Information

Taif Earth station

the technical and management skills necessary to operate and maintain effective telecommunications networks. Algeria, Egypt, and Iran, on the other hand, produce technicians but they are attracted by higher salaries to work in the Gulf States. This drain of skilled labor constrains absorptive capacity.

Skilled technicians and engineers who remain in their native country are in such short supply that the telecommunications industry must compete with other industries for their talents. Since the telecommunications networks in these countries are owned by the government, workers are often paid on a government scale, and job offers from private industry are likely to be more attractive. Moreover, the high dropout rates and problems in recruitment indicate that motivation among trainees in these countries is often low.

Photo credit: Aramco World Magazine

Saudi technician inspects computerized telephone network. Saudi Arabia was the first country in the world to install a nationwide stored program control telephone system

Several cultural factors also constrain absorption. In Saudi Arabia, for instance, cultural aversion to manual labor has limited maintenance training of nationals and focused attention on operations. In Iran, Bell trainers found that while apprentices were able to gain technical mastery of telecommunications equipment rapidly, administrative, management, and maintenance methods were, for them, abstract and foreign.

Capital Availability.—Each of these countries, except for Egypt, has been able to invest significant amounts of national revenues in development or renovation of telecommunications infrastructures. Only Egypt has been constrained by lack of available investment funds and has relied extensively on economic assistance for funding.

If a country can afford to pay for the importation and installation of telecommunications equipment and can afford to have foreign labor operate and maintain that technology, it may choose to continue that dependent relationship while investing its limited local manpower in other sectors of the economy.

Population Growth.—Another factor that constrains telecommunications capacity is the rapid growth of population in these Middle Eastern countries, especially in urban areas. This growth continually strains capacity, resulting in difficulties in maintaining a high quality of service.

Inconsistent or Changing Public Policy.—Consistency in public policy is important in achieving high levels of technology absorption, especially when the government is the owner of the technology and the major source of development funds. Some countries such as Algeria and Kuwait have reduced telecommunications and technical training budgets despite stated national objectives, as revenues declined or as political priorities changed. As a consequence, efforts to develop a skilled manpower base to operate and maintain the technology have been disrupted or delayed.

In Egypt, public-sector organizations have been mobilized to assist in solving the chronic unemployment problem. In response, the state-operated telecommunications authority employs almost ten times the number of workers required to operate and maintain the equipment. This has resulted in underemployment for some, the placement of unqualified workers in other functions, overall supervision problems, and a poor quality of service. In this case, one national goal—to improve the telecommunications infrastructure—has been balanced against other policy goals of reducing unemployment.

PERSPECTIVES OF SUPPLIER COUNTRIES AND FIRMS

The world telecommunications market is growing rapidly. According to some experts, sales of telecommunications equipment worldwide may double during the decade of the 1980's to $366 billion during the period.[72] Total sales amounted to $188.2 billion during the period 1970 to 1980. Sales in 1983 alone were about $59 billion. A significant portion of these sales will surely be in the Middle East. A plan adopted by the ITU to overhaul the public systems of 28 Middle Eastern and Mediterranean basin countries called for $30 billion (1978 dollars) in investments.[73]

Major supplier firms have several objectives in common in pursuing telecommunications transfers to the Middle East: 1) marketing in countries with a recognized need, technological requirements, and ample budget; 2) finding new markets once their own domestic markets have been saturated; and 3) building a solid reputation that can open foreign markets for other telecommunications goods and services. Major supplier countries also have interests in recycling petrodollars to equalize trade balances, opening markets for other types of exports, and in providing technical assistance to foster friendly relations with recipients.

More than 2,300 U.S. and foreign companies manufacture telecommunications equipment.[74] The number increases further if one adds suppliers of telecommunications support services—consulting, training, technical operations management, and maintenance. Competition among these suppliers is intense, considering that there are only about 100 major customers for public networks worldwide—i.e., the national PTTs.

This section focuses on the competitive position of U.S. and other supplier firms in this market—what the U.S. share of the market has been, how U.S. firms rank within the six national markets covered in this study, and how they fare within each technology sector. Finally, critical factors that have influenced competitive success in the Middle Eastern telecommunications market are identified.

United States

Observers disagree about why U.S. firms have not been more successful in sales of telecommunications equipment and technical services in the Middle East. On the one hand, businessmen see the efforts of the U.S. Government as insufficient and not on par with those of other governments, particularly with regard to export financing packages. On the other hand, many observers agree that U.S. sales in the Egyptian market stem directly from AID loans supporting telecommunications system expansion (see app. A, Egyptian project profile).[75] Some also feel that, until recently, U.S. firms were not anxious to tailor technology to foreign markets since the domestic U.S. telecommunications market is so large.

The American Businessmen's Group in Riyadh has taken the position that the U.S. Government has not provided the means to help U.S. firms bear the large financing demands involved in doing business in the Middle East. Small and medium-sized companies find it difficult to arrange adequate financing, and companies, large and small, cannot offer complete financing packages as comprehensive as that offered by the Siemens consortium in Egypt. Through the Export-Import Bank, the U.S. Government makes loans to foreign purchasers of U.S. goods. However, corporations want the bank to do more by providing such things as bank letters of guarantee, guarantees for tender and performance, and advance payment bonds. The Overseas Private Investment Corporation (OPIC) provides political risk insurance and guarantees to U.S. firms investing directly in less-developed countries, but the countries in which OPIC operates are limited by maximum gross national product (GNP) requirements.

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[72] A. Kamman, "World Telecom Market: Size and Potential," *Telephony*, Oct. 22, 1979, pp. 116-121; *Business Week*, Oct. 24, 1983; *Business Week*, Feb. 1, 1982.

[73] "Harnessing the Telecom Revolution," *Middle East Economic Digest, Special Report—Telecommunications*, October 1983, p. 2.

[74] AT&T Annual Report, 1981.

[75] Interviews with representatives of U.S. suppliers, March 1983.

The U.S. Government has, however, several established programs in the Middle East that particularly assist U.S. suppliers of telecommunications equipment. In Saudi Arabia, the U.S. Army Corps of Engineers is a consultant to the Ministries of Defense and Aviation in the design and contracting of military construction work. The Corps writes specifications, preapproves bidders, and evaluates proposals for the Saudis. In its construction jobs, there is usually a telecommunications component. The Corps plays a nonpartisan role in bid evaluations, and non-U.S. firms may be chosen as subcontractors.

USAID has contributed $242 million in loans and grants to Egypt since 1977, all tied to purchases from American telecommunications suppliers. AT&T, Ford Aerospace, Simplex, Continental Telephone, and Arthur D. Little have been the principal recipients. AID-funded contracts have included microwave equipment, traffic control equipment, TV broadcasting systems, navigation control networks, telephone cables, switching systems, and radar surveillance and remote-sensing equipment.

Thus, while U.S. Government personnel do not normally seek out export opportunities or carry on negotiations for sales of telecommunications equipment and services, as do other supplier governments,[76] government-supported programs such as AID's in Egypt have been important mechanisms for sales. (As discussed in ch. 11, there has been considerable debate among AID officials and U.S. policymakers concerning the appropriateness of these programs.)

The United States Telecommunications Training Institute (USTTI) was established in 1982 with U.S. Government support. The purpose is for private U.S. firms to share advances in telecommunications technology with developing countries. The establishment of the USTTI also reflected the recognition that most equipment and service supplying countries use training as a vehicle for entering markets in developing countries.

Training is performed in the United States by the corporate sponsors on their own equipment. Nearly 20 U.S. corporations have contributed over $2.5 million to the program in its first year including both capital and in-kind donations of technical personnel and equipment. In addition, the World Bank, the ITU, and other multilateral organizations have provided scholarships to help pay transportation and living expenses of the trainees.

In the past year, 14 percent of the trainees were from the Middle and Far East, with five from Saudi Arabia, one from Kuwait and one from Egypt. Some have suggested that the USTTI should collaborate with firms in sending personnel abroad to conduct training in developing countries. This would be an important learning experience not only for the foreign trainees, but also for the U.S. firms who seek entry into foreign markets. Others suggest that the training offered by the organization should stress lower level technical skill development to a greater extent.

The major U.S. telecommunications firms with dealings in the Middle East have been AT&T International, Continental Page, Inc., and General Telephone and Electronics (GTE).

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[76] Interviews with representatives of U.S. suppliers; November and December 1982.

France

Over the past decade, France has developed policies to promote the development of the nation's telecommunications industry. The government also encourages firms to target half of the equipment they produce for export markets. It has also assisted manufacturers in standardizing equipment to facilitate integration and export to other countries.

France is eager to maintain a strong export position in the Middle East to cover its imports of Middle Eastern oil, particularly oil from Saudi Arabia. In early 1982, France signed a liquefied natural gas (LNG) agreement with Algeria that included an accord to supply $2 billion worth of French goods and services, including telecommunications, to Algeria. French banks have also extended credits for export of telecommunications goods and services to Egypt.

In addition to export credits, the French government provides support to telecommunications exports through the DGT (Direction Génerale des Télecommunications), the telecommunications branch of the French PTT. DGT plays a diplomatic and consultative role, maintaining contacts with foreign telecommunications administrations and international bodies such as the ITU. DGT also provides information and consulting services.[77]

The major French telecommunications firms doing business in the Middle East have been Thomson-CSF and CIT-Alcatel.[78]

Great Britain

The British government in 1980 supported a high percentage (39 percent) of exports with official financing.[79] British firms have, however, lost ground as worldwide exporters of telecommunications equipment, and the government has not developed a strongly targeted policy similar to that of France.[80] Direct government support (including financing) for this industry thus appears to have been less extensive than in France or Japan.

In part, British telecommunications exports may have suffered, because British manufacturers have over-engineered and over-designed equipment to meet the standards of the government-operated domestic phone system.[81] As a result, their products have been uncompetitive, overpriced, and unsuitable for foreign markets.

In an attempt to turn this situation around, British Telecom, the government-owned phone authority, is cooperating with local industry to develop and market System X, a family of digital, microelectronic, and stored program control telephone exchanges. This system is intended to boost sales overseas and improve the reputation of British telecommunications technology. In addition, British embassy personnel in Saudi Arabia are reported to be effective in maintaining influential contacts with the Saudi PTT and arranging marketing meetings for British firms.[82]

Major British telecommunications firms involved in Middle Eastern markets are Cable and Wireless, Standard Telephone and Cable, Ltd., and Plessey Telecommunications and Office Systems, Ltd.

West Germany

West Germany has provided export credits to several countries in the Middle East. The

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[77] *Middle East Economic Digest, Special Report on Saudi Arabia,* July 1981; *Telecommunications,* March 1980.

[78] Some restructuring of the French telecommunications industry is now occurring in order to increase exports and keep France competitive internationally. Thomson-Brandt will transform its telecommunications interests, currently held by its subsidiary Thomson-CSF, into a new holding company called Thomson Telecommunications, under CGE's (Compagnie General d'Electricite) management. By 1987, CGE plans to merge its subsidiary, CIT-Alcatel, with Thomson Telecommunications, thus effectively becoming France's monopoly telecommunications producer. (*N.Y. Times,* Sept. 21, 1983; *Financial Times,* Sept. 16, 1983). See also "Telecom Giants to Join Forces," *Middle East Economic Digest—Special Report on France,* April 1984, pp. 4-5.

[79] Robin Day Glenn, *Financing of United States Exports of Telecommunications Equipment,* The International Law Institute, Georgetown University Law Center Monograph, Washington, D.C., 1982, p. 23.

[80] Ibid., p. 11.

[81] *Telephony,* Sept. 10, 1982.

[82] *Financial Times,* Jan. 6, 1981.

Siemens-led consortium was probably awarded the $1.8 billion Egyptian telephone expansion contract because of the financial package in which the West German government participated through export credits and soft loans. Export credits have also been granted for exports to Iraq.[83]

Domestically, the German government provides funding to local manufacturers for research and development (R&D). In 1979, for instance, the government committed approximately 3 percent of its total R&D budget to defray costs incurred by the electronics industry.[84] Siemens is the major West German firm involved in Middle Eastern telecommunications.

Sweden

Sweden has a well-organized government system for promoting sales overseas, although private companies compete with the government for business. Televerket (TVT) is a state-owned public utility that provides telecommunications services (telegraph, telex, telephone, data communications, radio communications) domestically and overseas. TVT has several manufacturing facilities, a consulting organization (Swedetel) that works primarily in developing countries, and a subsidiary (Swedcom) that installs, operates, and maintains telecommunications equipment in foreign countries. Another subsidiary, Teleinvest, acts as an export agent to assist in financing and export of telecommunications equipment manufactured in Sweden. In addition, the government provides some credit assistance for large projects in developing countries through Svensk Export Kredit.

Swedish government entities sometimes collaborate with private companies in selling products overseas. TVT and Ericsson are equal owners of a company called Ellemtel, which was set up to design and develop telecommunications equipment. Ellemtel developed the AXE exchange, for example. Private companies can call on Teleinvest to assist in financing and exporting products.

In 1978, faced with trade deficits largely caused by rising oil imports, Sweden initiated an export drive aimed at Middle Eastern countries. Banks increased their support to companies exporting to the Middle East, and the government organized trade missions for 100 Swedish companies. The Philips/Ericsson project in Saudi Arabia was reportedly won partly because two Swedish banks were approved as guarantors by the Saudi Arabian Monetary Agency.[85]

Canada

Bell Canada is one of the world's oldest telecommunications organizations, having started as a telephone company in 1883. It has since become Canada's principal supplier of telecommunications services, employing 57,000. In 1983, Bell Canada Enterprises was established as the parent company of a family of firms that includes Bell Canada as the operating telephone company, Northern Telecom as a manufacturing subsidiary, Bell-Northern Research as a telecommunications research and development organization and Bell Canada International (BCI).

BCI was formed in 1976 in response to strong overseas demand for consultancy services. It has performed telecommunications projects of all sizes throughout the world including the five-year Saudi management contract awarded in 1978, which at that time was the largest ($860 million) communications contract of its kind in history. Under this contract, Bell Canada would organize, operate, and maintain the expanding telephone system and train Saudis to take over the operation themselves. This contract was superceded in 1983 by a $1,297 million 3-year contract to provide the Kingdom with operations and maintenance service for its telecommunications expansion program. Bell Canada has carried out other work in Saudi Arabia including one contract for ARAMCO which has involved provision of advice on management methods and setting up a private communications network. They reportedly won these contracts because of their proven operating track record and extensive training experience.

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[83] John Whelan, "West Germans Win on High-Tech," *Middle East Economic Digest*, Jan. 29, 1982, pp. 10-11.

[84] *Telecommunications*, October 1980.

[85] *Telecommunications*, February 1982.

The next biggest Middle Eastern market for BCI is Iraq, which has become the largest customer for the supply, installation, and maintenance of Northern Telecom equipment. BCI first entered Iraq in 1976 when it installed an advanced Northern Telecom exchange on a turnkey basis—Iraq now has 60 of these exchanges.[86]

Netherlands

The Dutch have escalated their efforts to obtain a larger share of the telecommunications market in the Middle East. Their major company is N.V. Philips. Prior to 1978, Dutch exports of telecommunications equipment to the region were low. However, between 1979 and 1980 the Dutch government took several steps that improved their firms' competitive positions.

The Netherlands had encouraged cash outflows to stabilize the Dutch guilder. As a result, Dutch banks expanded their foreign interests and have been in a better position to assist companies with financing. Dutch government aid to developing countries, which represents about one percent of gross national product, also plays a role in influencing sales to the Middle East. As part of the Philips/Ericsson telephone contract in Saudi Arabia, the Dutch government provided a guarantee for financing.

Japan

Telecommunications operations in Japan have been handled under Nippon Telephone and Telegraph (NTT), a public corporation which is being reorganized. However, Kokusai Denshin Denwa (KDD) and private companies are important suppliers internationally. Although NTT has not been allowed to manufacture its own equipment, it helps Japanese manufacturers by advancing them part of the purchase price. This reduces costs and often enables them to underbid the competition.

The Japanese government has offered credits to some countries (Algeria for one) to purchase Japanese telecommunications equipment. In addition, the government sponsors high-technology research. NTT supports basic research in telecommunications—very large-scale integration (VLSI), optical fibers, and digital networks—and participating firms gain access to research results.

Japan has entered the Middle East telecommunications market only in the past 10 years. Many Japanese companies have become very competitive. In the early 1970's, exports represented only about 8 percent of Japan's telecommunications sales; in recent years they have made up nearly 20 percent.

Major Japanese firms active in Middle Eastern telecommunications markets are Nippon Electric Company (NEC), Fujitsu, Ltd., and Hitachi, Ltd.

U.S. Competitive Position

There has been volatility in the patterns of telecommunications exports of the major supplier nations. The increasing popularity of digital technology and the aggressiveness with which some suppliers have promoted product development have had important effects. Too, aggressiveness in designing effective marketing strategies and enlisting government support for these efforts have also been evident. Market shares of major suppliers in 1980 and net changes in worldwide market shares over the past decade are presented below.[87]

	Market Share		*Share Point Difference*
	1971	*1980*	*1971-80*
Japan	13.6	21.4	+7.8
United States	18.7	15.6	−3.1
West Germany	14.7	12.6	−2.1
Netherlands	7.4	7.2	−0.2
United Kingdom	11.1	7.0	−4.1
France	5.4	6.5	+1.1
Sweden	7.2	5.6	−1.6

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[86] "Bell Maintains Momentum in Saudi Arabia," *Middle East Economic Digest, Special Report on Canada*, May 1984, p. 11; see also H. R. Redmond, "Dynamics of Technology Transfer: Canada's Work in Saudi Arabia," *Telephony*, Aug. 24, 1981, pp. 30-32.

[87] *U.N. Yearbook of International Trade Statistics*, 1980.

Major shifts in market shares over the past 10 years consist of:

- A major increase in Japan's share, exceeding those of the United States and West Germany.
- A decline in U.S. and West German shares.
- A major decline in Britain's shares.
- A slight improvement in France's position.

Even small changes in share points are substantial when translated into dollars, since the size of the world market itself grew extensively over this period.

Japanese firms have benefited in the world market from the structure of Japan's domestic telecommunications market, the depreciation of the yen, and a major industrial shift to high technology industries. The French have marketed their advanced technology aggressively and have made major inroads in the sale of military equipment worldwide. On the other hand, the West Germans and British were late in developing digital telecommunications equipment to meet world demand.

Focusing more specifically on the six Middle Eastern countries in this study, the following suppliers have been dominant in the national markets for telecommunications equipment and services, based on contract activities between 1974 and 1982:

Algeria	1. Spain
	2. Sweden
	3. Japan
Egypt	1. France
	2. Germany
	3. Austria
Iran	1. United States (until 1979)
Iraq	1. Japan
	2. Sweden
	3. France
Kuwait	1. Sweden
Saudi Arabia	1. United States
	2. Sweden
	3. Netherlands
	4. France

U.S. firms were predominant in Iran prior to 1979, but their work then came to a halt. The only other national market in which U.S. firms have had firm control is Saudi Arabia. This situation is likely to continue. U.S. firms have also won large numbers of Arabsat contracts.

The positions of U.S. firms can be clarified further by analyzing market dominance at the technology sector level within each country. The sectors in the Middle East in which U.S. firms were strong competitors between 1974 and 1982 are shown in table 61.

In Algeria, U.S. firms had strong positions in two relatively small technology sectors—satellite and multiplex. In Egypt, the U.S. firms dominated or were strongly competitive in a variety of small sectors. The picture in Iran is very different; prior to the revolution, U.S. firms monopolized all of the key technology sectors except for video and radio broadcasting. In Iraq, the United States had virtually no presence, and penetration of the Kuwaiti market was minimal. Saudi Arabia is the one national market in which U.S. firms were predominant or strong competitors in all of the major technology sectors. U.S. firms also dominated in the regional Arabsat project.

It is difficult to discern any pattern in these data to suggest that U.S. suppliers are especially competitive in certain telecommunications technology sectors, except that U.S. firms have been dominant in satellite systems, both in satellite components and Earth stations. The ability to win contracts in Middle Eastern markets is determined by many factors, some of which are discussed below.

U.S. Supplier Advantages

Overall, U.S. suppliers have had a high technical reputation. U.S. technology has been viewed as being high in quality and dependable and reliable. Moreover, the reputation of U.S. telecommunications technicians and engineers is attested to by contracts from many national PTT ministries to provide consulting services to support planning, operations, and maintenance functions. After-sales service by

Table 61.—U.S. Competitive Position in Telecommunications Markets in the Middle East Between 1974 and 1982

	Dominant position	Strong competitor	Sector size (millions)	Total market
Algeria	Satellite	—	$ 11.2	$ 666.9
	Multiplex		1.8	
Egypt	Cable		230.4	2,800.0
	Microwave		72.5	
		Television	67.7	
	Consulting		35.1	
	HF Radio		9.2	
Iran (1974-79)	Switching		1,900.0	2,800.0
	Cable		689.9	
	Telex		18.0	
	Satellite		6.0	
Iraq	None	None		2,000.0
Kuwait	—	Television	7.0	431.0
Saudi Arabia	Switching		6,400.0	12,900.0
	Microwave		1,000.0	
		Radio	396.4	
	Mobile		257.5	
		Satellite	68.5	
	Other telephone		19.2	
		CCTV	18.9	
	Data Communication		18.6	
	Multiplex		4.2	
Regional	Satellite	—	234.0	294.3

SOURCE: Office of Technology Assessment.

U.S. firms was also highly regarded and viewed as dependable. U.S. manufacturers were also considered major suppliers of advanced technologies in emerging fields, such as data communications and office automation systems. In the six nations covered by this study, however, these high-technology areas were less important in trade than telephone and telex sectors.

Since most new telecommunications technologies involve the use of microchips, the competitive position of the United States, which is still one of the top suppliers of these valued components worldwide, has been boosted. In fact, several foreign manufacturers of telecommunications equipment (e.g., Thomson-CSF) were dependent on the United States for these components. Until recently, U.S. telephone companies outside the Bell system bought their small electronic switchboards from GTE, ITT, or Stromberg-Carlson Corporation. More recently, however, 75 percent of such sales have been made by the Japanese firms Oki Electric Industry Co., NEC, Hitachi, and Fujitsu. This suggests that one factor contributing to U.S. market shares in the past is now less important.

In addition to civilian communications equipment, many U.S. suppliers are major manufacturers and exporters of high-technology military communications products. Military communications networks are a major technological component in command and control, military preparedness, and national security, and thus are central to the modernization of a nation's armed forces. U.S. military equipment sales have served to facilitate the sale of both military and civilian communications equipment.

As discussed earlier, U.S. government programs in Egypt and Saudi Arabia promote telecommunications technology transfers to those countries.

U.S. Supplier Disadvantages

Probably the most important difficulty experienced by U.S. suppliers of telecommunications equipment and services has been in establishing competitive prices and in arranging comprehensive financing packages. Not heavily subsidized domestically or for export, the industry must reduce its costs internally through higher productivity and lower overhead to come up with the best pricing bid.

U.S. suppliers have at times been at a disadvantage in competing against firms in Japan and Western Europe, where governments provide complete and attractive financial packages. Although U.S. Government agencies such as the Export-Import Bank and OPIC support U.S. exporters, they apparently have not had the flexibility of some foreign governments in providing long-term soft loans, extensive export credits, and bartering arrangements. For example, a West European consortium won the $1.8 billion contract for modernizing Egypt's telephone network, reportedly primarily because of the attractive financing offered with the assistance of their governments. This project is described in appendix A.

Most U.S. suppliers, catering primarily to the domestic market, design their equipment to North American standards, which are modifications of CCITT norms. Except for Saudi Arabia, the six Middle Eastern countries in this study, as well as most European nations, abide by straight CCITT norms. Some have viewed this as a problem for U.S. suppliers, but Japanese manufacturers also produce equipment for their domestic market using modified CCITT norms.

Until recently, U.S. firms did not actively market digital electronic switching technology abroad. In comparison to the product lines of digital switching leaders, such as CIT-Alcatel and Ericsson, U.S. modern analog offerings were not as sophisticated or new. Moreover, U.S. prices were high for this older technology. On the other hand, some U.S. manufacturers (GTE for instance) have been bidding on digital equipment contracts. In fact, some suppliers offer greater flexibility to customers because they do not restrict themselves to sale of their own equipment. (In certain cases, this last point may constitute an advantage.)

In addition to complaints about weak U.S. government representation of business mentioned earlier, Government regulations and taxation were said to impede the flexibility and competitiveness of U.S. suppliers. Recently, however, many of the obstacles for U.S. firms operating overseas have been moderated. Tax laws were changed in 1981 to relieve U.S. citizens working abroad of paying taxes on the first $75,000 earned. (Workers from Japan, West Germany, Great Britain, Italy, France, and Sweden do not pay taxes on salaries, bonuses, health insurance, or retirement benefits earned overseas.) In 1982, revisions were made to the Sherman Anti-Trust Act, relaxing restrictions on companies involved in foreign trade. The Export Trading Act of 1982 and the Bank Export Services Act established an office in the Department of Commerce to promote export trade associations and investment in export trading companies.[88]

U.S. firms have also complained about other laws which have not been changed, such as the antiboycott program and the Foreign Corrupt Practices Act (FCPA) of 1977. The FCPA, they say, makes little distinction between bribes and commission agent fees or foreign sales representatives' bonuses. In many Middle Eastern countries, they claim, these costs are the accepted mode of doing business.[89] Some businessmen also claim that in Algeria, where the agent system does not operate, corruption is minimal. However, OTA's research did not uncover any cases where the FCPA was a major factor in lost sales. The Arab boycott of Israel influenced the nature of contract awards, as mentioned earlier, by Arabsat. U.S. firms were, however, able to participate.

In general, the following factors, ranked roughly, have been critical in marketing telecommunications technology effectively in the Middle East.

1. *Low price.* Despite their large revenue base, many of the oil-producing countries are increasingly cost-conscious. Price has often been the most important decision criterion.

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[88] Public Law 97-290, 1982.

[89] Charles Wohlstetter, chairman of Continental Telecom, Inc., says his company could not win a contract to install a phone system for Saudi Arabia because "we were unable to pay a bribe." U.S. law, he says has kept "American companies from providing big systems in the Middle East," *Business Week*, Oct. 24, 1983.

(See, for example, the Saudi Arabian telephone expansion project profile, appendix A.) In fact, selection of the low bidder is sometimes mandated by law. Depreciation of certain national currencies over the past few years and the ability of companies to profit from domestic subsidies have tended to make particular suppliers more attractive.[90]

2. *Complete financial package.* Ability to supply a complete financial package with attractive terms to the buyer is often a key determining factor in a contract award.

3. *Reputation.* Technical competence, product reliability, and the ability to point to operating installations using the supplier's equipment are key selling factors.

4. *After-sale support.* A supplier's willingness to train local personnel, provide spare parts, and operate and maintain the equipment it installs is a critical decision factor. This type of commitment is often exhibited through establishment of a local office or joint venture.

5. *Associated business deals.* By offering extra "carrots," suppliers can develop unique packages that are attractive to the buyer. For instance, in addition to the telephone modernization work in Egypt, the Siemens consortium promised to conduct efforts to improve railway signalling and rolling stock, perform a feasibility study on Egyptian coal resources, and establish a joint-venture consulting organization. Moreover, Thomson and Ericsson apparently tie civilian communications sales to military equipment transfers. On the other hand, the reported attempt by U.S. suppliers to link an Egyptian telephone project to a threat of withdrawing certain military aircraft sales, was not successful.

6. *Early program involvement.* Participation by a foreign contractor in a program's early stages—a pre-engineering or master plan phase—is often helpful in gaining the customer's confidence and in establishing an organization in-country to handle the follow-on tasks. This was true in the case of AT&T in Iran and, in part (since the Siemens consortium won the large contract), with Continental Telephone in Egypt. Being the first to introduce a new technology in a country—microwave networks, digital electronic switching, Earth stations, or mobile radio networks, for instance—has also assisted companies in gaining control of those markets.

7. *Local operations.* In each of the six countries except Algeria, it is necessary to operate through a local agent. As discussed in appendix A, the Ericsson/Philips/Bell Canada consortium was said to have been aided in its successful bid by use of Prince Fahd's son as an agent. In most countries, joint ventures with local interests are given preference in contract award evaluations. Such joint ventures, however, may involve potentially costly risks, since suppliers have less control over their investments.

8. *Political neutrality.* Political neutrality in Middle Eastern issues has apparently enhanced Japan's opportunities to export to a wide range of ideologically diverse Middle Eastern countries. In other cases, such as Saudi Arabia and Egypt, political alliances have served to promote U.S. telecommunications exports.

9. *Corporate financial soundness.* In order for a supplier to profit in conducting business in the Middle East, it must be able to withstand payment delays, as well as a host of other investment risks.

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[90] As stated by John L. Moore in R. D. Glenn (op. cit., 1982), "The currency relationships are such that one could almost rule U.S. companies out of competition on price, without regard to project finance, except in projects where the U.S. still has an edge on technology or mass production due to the scale of our economy, or efficiency and certainty of meeting delivery schedules."

IMPLICATIONS FOR U.S. POLICY

Specific U.S. laws and policies, such as the Foreign Corrupt Practices Act, taxing of U.S. workers abroad, and antiboycott legislation, although having an influence, have not been major determinants of U.S. competitiveness in Middle Eastern telecommunications markets. Although together they do represent obstacles to U.S. suppliers, the major factors sometimes negatively affecting U.S. presence and market share have been price and financing arrangements of foreign competitors. Technical reputation, reliability of spare parts supply and after-sales service, and favorable diplomatic ties follow as secondary determinants.

U.S. foreign policies have set the context for trade. The United States has had great success in countries with favorable ties, such as Saudi Arabia, prerevolutionary Iran, and, increasingly, Egypt. U.S. supplier presence in Iraq and Algeria has been minimal, and it is nonexistent in present-day Iran.

The United States is an acknowledged leader in state-of-the-art telecommunications technologies, such as satellite systems, but these have often represented smaller dollar-volumes of sales in the Middle East. The more conventional technologies and the increasingly dominant digital systems are strong technologies for non-U.S. suppliers, technologies that are often tailored by them to export markets and can be promoted effectively against a strong dollar, particularly with advantageous financing.

Some options could be considered which could assist U.S. firms in winning sales of telecommunications equipment and services which help promote the Middle Eastern nations' development plans. They include:

1. Establishing more foreign manpower training programs in the telecommunications field, which increases expertise and familiarizes Middle Easterners with U.S. equipment. As one example, the U.S. Telecommunications Training Institute involves a number of U.S. firms working in a joint effort supported by the U.S. government.
2. Promoting mutually advantageous development assistance/contingent contract awards. This could be accomplished by explicitly linking assistance and export programs (through use of mixed credits)[91] or by expanding technical assistance programs in telecommunications involving private U.S. firms as well as government agencies. (As discussed in chapter 13, many fear that assistance goals could be distorted by explicit linkage.)
3. Promoting regional cooperation in telecommunications. This approach would only improve the positions of U.S. firms if their participation was central to cooperative technical efforts, such as in a telecommunications technology transfer center.
4. Upgrade the technical expertise of Foreign Commercial Officers and AID staff to deal more effectively with telecommunications-related projects.

OTA's research indicates that the comparative position of U.S. firms in Middle Eastern markets stems only in part from U.S. Government policies. With the assistance of the U.S. Government, financing, commercial representation and cooperative programs involving private-sector firms could be improved; but the marketing and technology transfer efforts of the firms themselves are key determinants of success in contract competition. Indeed, telecommunication technology transfers to Egypt and Saudi Arabia have certainly been promoted by U.S. Government policies.

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[91] In July 1984, the U.S. Export-Import Bank announced that it would provide 90 percent financing and 8 percent interest to support the U.S. firm Scientific Atlanta in its bid to sell a satellite communications network to Algeria. This step was taken in an effort to counter Japan's use of mixed credits. See *Washington Post*, July 11, 1984, p. D1.

CONCLUSIONS

Despite overuse of the term, there has indeed been a world telecommunications revolution in the last decade. With telecommunications deregulation in the United States and pressures to deregulate in other countries, changes in the next decade may be even greater. What was previously a necessary but not very dynamic sector, generally run by a governmental PTT, telecommunications has been transformed with computers, microchips, and satellites into a sophisticated, rapidly changing sector. Even firms in industrial countries have been pressed to keep up with recent developments in automatic exchanges, fiber optics, data transmission, digital systems, and satellite technology.

Technological advances in telecommunications come rapidly—systems can become obsolete before they are installed. Distinctions between communication, information transfer, and processed data are no longer clear, owing to improved communication links, increased computer ties, and transborder data flows.

In the Middle East, the gradual shift from conventional analog to digital electronic equipment will become even more apparent, as will a shift from large public network development to sophisticated systems and services for private end-users. Service industries involved in repair, maintenance, and supply of the telecommunications infrastructure can be expected to develop in the private sector within the recipient countries. Computer and data-processing industries are also likely to emerge. Banks and financial institutions have already been among the first to push for sophisticated telecommunications services, office automation, and data-communications features.

Despite the stated desires of the Middle Eastern nations and the well-conceived plans for domestic as well as regional communications, there is great disparity in the availability of telecommunications facilities, the reliability and efficiency of operations, and usage from country to country. Systems range from the efficient, heavily used, but possibly soon-to-be-overtaxed systems of Saudi Arabia and Kuwait; to the Egyptian system, where less than one local call in three is completed; to Iran, which recently had an average of only 13 domestic calls per subscriber per year over the 3.4 lines per 100 inhabitants. The local need is there; pent-up demand exists across all telecommunications sectors and represents excellent future markets for foreign suppliers; potential also exists for developing indigenous capabilities in equipment manufacture, installation, operation, and maintenance.

In telecommunications, several critical factors tend to facilitate technology absorption by Middle Eastern countries: they include a national resolve to build adequate infrastructure, demand for telecommunications technology from other sectors of the economy, strong national security objectives, the existence of domestic telecommunications production facilities, and decisions to stay with more conventional technology. Factors constraining absorptive capacity in telecommunications include skilled manpower shortages, rapid population growth (producing burgeoning demand), and inconsistent or changing public policies regarding telecommunications development.

U.S. firms have done relatively well in advanced telecommunications sectors in the Middle East—but these, up to now at least, represent small dollar amounts in total telecommunications expenditures in the region. U.S. suppliers have exported many types of telecommunications technologies to Saudi Arabia and pre-revolutionary Iran, but overall, the U.S. firms have not been a dominant force in telecommunications trade in the region. This has been due to many factors, including political relations between the U.S. and nations in the region, a strong U.S. dollar in recent years, and difficulties in arranging financing as compared to the financing offered by other suppliers. In addition, until recently, the large, "captive" U.S. domestic telecommunications market was the prime concern of U.S. equipment suppliers.

U.S. policy options for improving the positions of U.S. firms and for furthering development goals of the Middle Eastern nations include improving the technical capabilities of U.S. commercial representatives in the region, allowing more flexibility to government agencies in arranging financial assistance to exporters, promoting regional cooperation in telecommunications, and increasing cooperative technology transfer efforts involving the private sector.

APPENDIX 6A.—TELECOMMUNICATIONS PROJECT PROFILES IN SELECTED MIDDLE EASTERN COUNTRIES

SAUDI ARABIAN PROJECT DESCRIPTIONS

Telephone Expansion Program[1]

The Saudi Arabian Telephone Expansion Program, an ambitious program to expand the telephone network in Saudi Arabia from 200,000 lines to 1.2 million in a 5-year period, began in January 1978. A consortium of Ericsson (Sweden), Philips (Netherlands) and Bell Canada head the project team. There were three serious bidders considered by Saudi Arabia for this job—the Ericsson/Philips/Bell team, ITT (U.S.), and Western Electric International (U.S.). Separate cost estimates were requested from each bidder for the three segments of the contract—urban systems, rural systems, and operations and maintenance. Overall, the winning contractors offered the lowest bid, as can be seen below:

Bids (in billions of U.S. $)

	Urban	*Rural*	*Ops & Maint.*	*Total*
ITT	$1.25	$0.20	$2.00	$3.5
Western Electric	1.47	0.23	1.20	2.9
Philips/Ericsson/Bell	1.49	0.25	0.47	2.2

While ITT projected the lowest costs for the urban and rural systems, it estimated the highest costs by far for the operations and maintenance segment of the job. Western Electric's estimates in this regard were also almost triple that of the non-U.S. consortium. The high cost estimate for this work segment may have been instrumental in the final selection, since it portends future operations and maintenance costs for the equipment proposed by each supplier. Another factor in the bidding that probably influenced the award decision was that Philips had hired Prince Fahd's son as its agent in Saudi Arabia. In terms of financial arrangements, the Dutch firm arranged for guarantees from three banks and received a direct Dutch government guarantee. The Swedish firm was able to amass a $277.4 million guarantee through Citibank (U.S.) and 11 other Swedish banks.

The evaluation team consisted of members of the Saudi PTT, Norconsult (Norway), Arthur D. Little (U.S.), and the International Telecommunication Union.

The total contract has grown from $2.2 billion in 1978 to over $5.0 billion. The project's scope includes installing the world's first national stored program control (SPC) telephone system. Over 795,000 new lines were to be installed and 197,000 existing lines on crossbar exchanges were to be converted to computer control. In addition, a national automatic mobile telephone system was to be installed.

Philips and Ericsson agreed to split the work and revenues equally. Essentially, each firm supplied the following equipment:

Ericsson	*Philips*
Large-capacity local exchanges	Small and medium exchanges
	Container exchanges
Rural container exchanges	PCM multiplex equipment
All-tandem trunk and international exchanges	Trunk cables and most local cables
Equipment to upgrade existing crossbar exchanges	Building designs
	Subscriber rural radio
All telephone instruments, coin boxes, and mobile telephones	
Some local cable	
All network equipment	

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[1] R. Raggett, "Desert Project Blossoms," *Telephony*, July 28, 1980; *Intel-Trade* April 15, 1979; *World Business Weekly*, June 9, 1980; *Middle East Economic Digest*, July 1981, Feb. 19, 1982, Oct. 9, 1981, March 13, 1981, May 23, 1980, Aug. 17, 1979, Feb. 17, 1978.

Bell Canada's role involved a 5-year operations, maintenance, and training function. Given its $1 billion segment of the job, Bell Canada was to establish and control Saudi Telephone under the auspices of the Saudi PTT. Its other functions included installing and maintaining subscriber lines, indicating new network installation priorities, assisting in the test and acceptance procedures, training, subscriber billing, developing phone directories, and building construction.

The consortium drew on 200 subcontractors to supply equipment and services. Principal among them was Dong Ah Company (South Korea), whose functions were to construct, install, and provide initial maintenance for the outside plant and buildings. Norconsult and A. D. Little provided consulting services.

The contract was based on a pre-engineering study conducted by A. D. Little in 1974-75. Its report recommended that the Saudis update existing crossbar exchanges with digital equipment, expand the phone network, and increase the number of main phone stations by 476,000 digital lines.

After the initial contract was signed, Philips and Ericsson formed a Saudi joint venture to manage the supply and installation of equipment and coordination of other subcontractors. One of the first tasks was to provide living quarters for the employees. Three fixed-location villages were constructed beginning in 1978 near Riyadh, Jeddah, and Dammam for 1,500 employees and their families at a cost of $48 million. Compounds for 230 unmarried employees were also developed in Riyadh and Jeddah. In addition, mobile camps for installation engineers in remote areas were established. Although the Dutch and Swedish employee population was the largest, 43 other nationalities were represented, including many British. Dong Ah brought in more than 6,000 Koreans and Indonesians. The crew was characterized by a very low absentee rate and high contract renewal rate.

To meet the very tight schedules, a massive logistics effort had to be planned and executed to transport equipment to the required sites. Over 200,000 cubic meters of supplies were shipped from Europe by air and sea and then stored in Jeddah and Dammam until distributed by truck. To avoid on-site delays, exchanges were pre-assembled in Europe before shipping. A minicomputer was also shipped to the consortium's on-site headquarters to help plan, project, inventory, and control the complex production schedule. Detailed monthly progress reports were generated in English and Arabic for discussion with the PTT, consultants, and subcontractors.

Other obstacles also emerged as the project progressed. Local and municipal government officials had to give their consent to where the trenches were dug and where buildings could be located. Only Muslim staff were allowed into the holy cities of Mecca and Medina. Subscriber hookups were often delayed because Muslim custom prevented telephone technicians from entering homes when a male member of the household was not present. Moreover, the two consultants, A.D. Little and Norconsult, modified priorities over the course of the contract, given new developments in technology. Their recommendations resulted in the use of fiber optic technology in Riyadh. At the same time, the project team had a goal of keeping the systems within the operational capabilities of Saudi personnel, despite the advanced technology that was employed.

Training occurs in Europe, Canada, and on-site. While few trainees have any technical background, they undergo an intensive program that covers the outside plant and the inside plant (operations, system maintenance, and technician levels). Trainees get 2-3 months of field experience between course segments. There has been some difficulty in finding sufficient numbers of trainees; highly qualified engineers are often attracted to private companies. There has also been a high dropout rate.

So far, the system has experienced minimal downtime and is highly responsive in providing customer services. There is also a high usage rate among new subscribers, helped along by low phone rental charges and low rates for calls.

Intra-Kingdom Microwave Program[2]

Western Electric International Inc. (now a part of AT&T International) was awarded this $408 million project in June 1977 by the Saudi PTT, based on a tender released in September 1976. The job entailed the engineering, furnishing, installation, operation, and maintenance functions for 12 months, and the training of local personnel for a 6,200-mile, 46-route, 300-site microwave communications project. The system was built to provide 35,000 long-distance telephone circuits, as well as telex, television, and data transmission channels. In addition, a 405-phone emergency roadside system was designed and installed, as well as 10 maintenance centers and two surveillance centers to detect faults in the system. The system was integrated into the national long-distance network. This project was actually begun by the Italian firm, SIRTI, which provided microwave links between Jeddah, Taif, Riyadh and Dammam. Norconsult of Norway, Swedetel of Sweden, and Preece, Cardew, and Rider of Great Britain were consultants to the Saudi PTT on this project for the SIRTI and Western Electric phases.

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[2] K. Jackson, "Linking up with the Future," *Telephony*, Aug. 27, 1979; *Saudi Arabia Yearbook 1980-81; Middle East Economic Digest*, August 1978, Jan. 23, 1981, Oct. 5, 1979, January 1981, Aug. 27, 1982; *Electronics News*, Sept. 6, 1982; *Intel-Trade* Apr. 15, 1979.

Western Electric, as prime contractor, was responsible for overall orchestration of the project. It supplied the multiplex equipment. Rockwell-Collins Systems International, Inc., of Dallas, was a major subcontractor (with a contract worth more than $100 million), supplying the radio relay equipment and supervising field testing. Anixter Communications Systems constructed over 687 shelter modules; Charles Payne and Company helped design and engineer the shelter building; Shafat GmbH supplied the AC generators and Harmer & Simmons Ltd. provided the DC generators. Other subcontractors were used to supply towers, antennas, and in-country construction and support services.

The project team faced several difficult problems from the outset:

- Tight schedule: The first eight routes were promised to be cut into the national system within 16 months, with the rest of the system completed in phases by 30 months (December 1979). Some estimates suggest that given the extensiveness of the work, it would normally take at least twice as long to complete a project this size.
- Equipment protection: Techniques had to be developed to protect the sensitive equipment against a harsh environment.
- Transportation and installation: Problems arose in transporting the equipment and installing it in a country with limited facilities and limited trained technical help.

In order to meet the tight schedule, Western Electric immediately commenced production of the multiplex equipment. Living quarters and offices were constructed immediately in several locations. Sites for the microwave stations were inspected. An assembly and equipment testing facility was established in Atlanta. To avoid on-site problems, it was decided to assemble the system components in a modular fashion in the United States and implement needed changes in the United States before shipment. In line with this decision, the equipment was preinstalled in shelters.

Project requirements and environmental conditions necessitated modification of some equipment design. The radio relay and multiplex equipment at each site had to operate unattended for 4 months at a stretch, with high reliability and minimal maintenance. There was also a need to design and produce transportable, stand-alone, and self-powered buildings with an air-handling system that provided air conditioning and dust filtration.

Bell Laboratories was commissioned to modify Western Electric multiplex designs developed for the U.S. market so that they would meet international standards. A building was developed to shelter site equipment to withstand desert and mountainous conditions, salty sea air, high and low temperatures, and possible earthquake tremors. Bell Labs, along with Payne, designed a lightweight, strong, and insulated shelter that doubled as a shipping container for the equipment. These units were developed in a modular fashion to allow them to be fit together in different patterns to meet the particular specifications of each site. The modular design was also efficient for preassembly, with power generators being shipped directly to Saudi Arabia from their European suppliers.

Western Electric provided training on the microwave network in system management and technical operation. This was conducted at the same time the system was being designed and installed. Although Western Electric maintained the system for the first 12 months after completion, Sartelco, a joint Saudi-Italian venture, won the subsequent $75 million maintenance contract. It will use 120 Italian and 180 other technicians on its staff, several presumably being Saudi nationals.

The Saudi PTT in August 1982 awarded AT&T International a $377.5 million contract to expand the microwave network and supply 150 new towers. This will double the existing telephone capacity to 70,000 voice frequency channels and expand and strengthen the network's radio and TV channels.

EGYPTIAN PROJECT DESCRIPTIONS

Telecommunications Modernization[3]

The modernization of telecommunications in Egypt was awarded to a European consortium consisting of Siemens (West Germany), Thomson-CSF (France), and Siemens Austria in September 1979. No formal request for tenders was ever issued. However, following the completion of the 20-year master plan by Continental Telephone International (U.S.) in 1978, several firms made presentations to the Egyptian PTT describing how they would implement it.

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[3] *Middle East Economic Digest*, April 1979, Sept. 21, 1979, January 1981, Oct. 15, 1982, Oct. 24, 1980; Frith, Kirk, and Spinks, 1980.

Major competitors included an American consortium consisting of Continental Telephone International, AT&T, and GTE. Ericsson, ITT, and Philips were also serious contenders. The most important factor in the Egyptian award decision was financing. Egypt was looking for 75 percent of total financing from the supplier countries and the remainder from financial institutions. The European consortium was the only bidder that could provide this type of package. Soft 15-year loans with 5 percent interest and a 5-year grace period were offered by the three supplier countries in the consortium. Moreover, supplies and export credits were made available by France and West Germany.

The winning team used other marketing strategies as well in its successful bid. While the master plan identified a $2,400 million expenditure in the first 5 years of implementation, the consortium estimated the cost to be only $1,800 million. The consortium also benefited from the intervention of Austrian Chancellor Bruno Kreisky, who, as a long-time friend of President Anwar Sadat, sent a personal emissary to Egypt to promise additional German and Austrian investments in Egyptian industrialization. Siemens Austria promised to finance the renovation of Egypt's railway signaling network and its rolling stock. Siemens promised to finance a feasibility study along with Krupp of West Germany on Egypt's coal resources. In addition, the two companies offered to establish a management consulting firm along with Egyptian interests.

The other bidders also made their interests known to Egyptian authorities, although they could not match the low-cost, long-term financing package of the consortium. The U.S. team sent its chairmen and presidents to meet with President Sadat and present its proposals. European bidders held that the U.S. team attempted to tie the sale to possible U.S. military exports to Egypt and tried to prevent open tendering. Using a less aggressive, but persuasive strategy, CIT-Alcatel (France), which was already under contract to install digital electronic switching systems in Egypt, received permission from the French PTT to install equipment originally earmarked for domestic use in order to meet contractual deadlines.

Although the contract was awarded in September 1979, work startup was delayed for over 3 years, until October 1982. This delay resulted from details in the agreement that still needed to be finalized. Siemens agreed to a memorandum of understanding concerning the prices for equipment (which could be no more than 15 percent higher than U.S. equipment provided under the AID package) and the use of local contractors for civil works (laying cable and installing ducts). Thomson agreed to a similar memorandum on prices, engineers' salaries, and training of Egyptian technical personnel. The contract and memoranda then had to be ratified by the Egyptian parliament.

The scope of this 5-year project includes: 1) installation of 500,000 new phone lines and renovation of 350,000 existing lines, losing 100,000 existing antiquated lines in the process; 2) supply of analog switching systems; 3) provision of coaxial cables in Lower Egypt and microwave systems for Upper and Lower Egypt linked to Cairo; 4) establishment of repair centers; 5) provision of 3 years' supply of spare parts; and 6) training of Egyptians to enable handing over of operations within 3 years.

The Continental Telephone master plan projected that additional telecommunications projects through the year 2000 could amount to over $17 billion. The European consortium would appear to be in the most advantageous position to win much of this additional business.

Technical and Managerial Services[4]

Following the submission of Continental Telephone's master plan for Egypt's telecommunications system in 1978, the company put in a bid, along with AT&T and GTE, to implement the first 5 years of the plan. It lost to the Siemens consortium. In May 1980, a contract was awarded to Continental Page Consultants (a subsidiary of Continental Telephone) and Arthur D. Little International for $20.5 million to supply managerial and technical advisory services. Of the total, $17.4 million was provided by USAID. Consulting work is expected to continue through 1985.

The work is equally divided between the two firms. A. D. Little is focusing on improvements in planning, management, operations, and training. Specifically, the company will design and develop managerial, financial and data systems. Continental is providing more of the technical, plant-related work—rehabilitating existing equipment, designing and installing four electronic exchanges and three outside plant systems in Cairo and three electronic exchanges and outside junction cables in Alexandria, and training Egyptian personnel in operations and maintenance. The team will award hardware contracts to U.S. firms.

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[4] *Telephony*, June 16, 1980. *Communicator*, summer 1981.

In the training effort, Continental is attempting to transfer not only specific knowledge on installation and repair, but also broader technical concepts on the operation of telecommunications networks. On-the-job training is implemented along with extensive formal classroom training. Owing to language barriers, Continental trains Egyptian instructors who then teach the craft employees.

ALGERIAN PROJECT DESCRIPTION

Telecommunications Project[5]

This project was awarded in 1974 to a U.S. firm following a competition involving about 12 companies; the United States and Japanese firms were the front runners. The apparent critical factors in winning the contract included: 1) a desire by the Algerian PTT to loosen its dependence on the French; 2) a desire for reliable U.S. technology, and, most importantly, 3) price. The American firm offered the lowest bid.

Project specifications in the tender were written by another American firm that had conducted a 1-year pre-engineering study prior to the award. This firm continued to provide consulting assistance to the Algerian PTT for 4 to 5 years into the contract.

The contract had open financing, which resulted in payment delays of 2 to 3 years. No irrevocable letter of credit was issued by the PTT to ensure payment. Apparently, Algerian ministries will not issue such letters to foreign contractors, but some national companies will. As a result, large amounts of investment capital were put at risk by the company.

The project staff consisted of 42 employees at its peak, mostly American and British technicians, with nationals hired for clerical assistance. No PTT personnel participated in the project with the contractor's staff; it was handled as a turnkey operation. The work involved installation of equipment, sometimes in remote sites. No major modifications to the equipment were required, although additional engineering costs were entailed to deal with special ventilation and sand filtration systems that were necessitated by local conditions. In some locations where the equipment was installed, climatic and terrain problems resulted in difficulties with the dual diesel generators.

For 3 years after installation, the firm was under contract to operate and maintain the equipment and train nationals. Formal training of about 40 Algerians took place in the United States and Algeria, with on-the-job training for 3 years side-by-side with American and British technicians. The training was provided in French or with translators. Most trainees had some form of engineering degree, but their formal education and practical experience varied widely. Most visible to the trainers was the apparent lack of motivation by many nationals in the program. While some equipment sites were well maintained with low downtime records, others were in poor shape.

The U.S. Government played no role in aiding the company to obtain the original procurement. During the course of the project, the program manager as well as other American businessmen had regular meetings with the U.S. ambassador to discuss problems encountered in conducting business in Algeria. Common difficulties included local taxation, contractual problems leading to nonpayment, and problems in getting contractor property out of the country after the project was completed. Although the ambassador listened, the businessmen felt that no action was ever taken by the U.S. Government to remedy these problems or to bring them to the attention of the Algerians on a government-to-government level.

The last Americans involved in the project finished their tasks and left Algeria in 1980. Since then, the Algerian PTT has issued a tender to purchase more of the same type of equipment. While the American company that provided the original systems is in a dominant position relative to foreign competitors, it has decided not to bid because of the investment risks and financial losses it experienced during its initial contract.

IRANIAN PROJECT DESCRIPTION

Telecommunications Training Program[6]

American Bell International Inc. (ABII), a subsidiary of AT&T, began work in Iran in 1975 to evaluate existing telecommunications facilities and to identify future requirements. This work was initially conducted under contract to the U.S. Air Force, which was a consultant to the Iranian government. A year later, a master plan for telecommunications service was completed and ABII was awarded a new contract to help implement the 10-year plan. Chief among ABII's tasks was technical consulting, integrating and supervising other contractors, and training Iranian managers, engineers and technicians in the efficient operation and maintenance of the evolving network. ABII reported to the managing director of the Iranian PTT.

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[5] This description is based on interviews held in December 1982 with a program manager at a large U.S. telecommunications manufacturer that has done business in Algeria. Details of the technology itself have been omitted to retain anonymity.

[6] Interview with supplier representative, held in December 1982; *Telecommunications*, August 1979.

By mid-1977, the training effort began with a staff of six people. By 1979, before the overthrow of the Shah, the effort included 29 ABII trainers and over 100 Iranian trainers. Most of the training took place in Teheran and several field locations, although some initial formal instruction was conducted at AT&T facilities in the United States. Training was conducted in Farsi by Iranian instructors and translators. However, highly technical hardware courses and management courses were taught in English.

Iran's stated goal was to establish self-sufficiency in training within 10 years. With this in mind, joint training policy committees were formed so that Iranian management would feel a sense of ownership in the contractor's training program. An Iranian training organization was established and courses were developed in coordination with ABII.

Hardware training dealing with maintenance and repair was developed by several equipment manufacturers. Successful graduates were then to train other employees in the field. This instruction proved to be effective in that it was practical and involved hands-on experiences. Courses included: 1) telephone maintenance procedures, 2) telephone cable fault locating, 3) management training, 4) record keeping for outside plant facilities, 5) cable laying, 6) outside plant engineering, and 7) sources of supply.

Other conceptual and management courses tended to be more difficult for the Iranians to grasp. The management skills courses proved to be too culture-bound and alien to many Iranians. The PTT also gave higher priority to the technical courses, giving management and administrative courses second place. Concepts such as team problem-solving skills, which are common in the West, were difficult for the Iranian trainees to accept and implement. Dropout rates in some of these courses reached 50 percent. In retrospect, some of the ABII trainers felt that these concepts should have been introduced more slowly, and a more extensive cultural orientation should have been given to Americans before they were sent to Iran.

CHAPTER 7

Technology Transfers in Commercial Aircraft Support Systems

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CHAPTER 7

Technology Transfers in Commercial Aircraft Support Systems

INTRODUCTION

The Middle East has been one bright spot in the generally depressed worldwide commercial airline industry in recent years. Sales to the region of large commercial aircraft and related services required to support airline operations grew dramatically in the 1970's and have continued into the 1980's, despite the recent depressed condition of world air transport. This was due to both increased oil revenues and to the increased transport needs of the Middle East during their decade of dramatic business expansion. The airlines of the Middle East have the newest fleets in the world, with the average age of jet and especially nonjet aircraft considerably lower than the world average.[1] The number of passengers carried by Saudia alone increased from 1.3 million in 1974 to 10 million in 1982. From 1980 to 1981, Kuwait Airways ranked second in the world in growth rate of scheduled revenue tonne-kilometers performed.[2] According to International Civil Aviation Organization (ICAO) statistics, scheduled air passenger traffic in the Middle East region will increase by 10 percent annually up to 1992. This represents the most dynamic growth pattern of any region in the world.[3]

While the Middle Eastern countries may have the financial resources necessary to purchase aircraft, operations and maintenance require substantial ongoing efforts. Whether commercial airlines are mere symbols of national prestige or important components of economic and technological development depends on the extent of technology transfer, particularly in aircraft support systems.

Commercial aircraft support systems cover a wide range of capabilities which include: 1) airport design, construction, and management; 2) basic airplane ground support including fueling and loading/unloading of passengers, baggage, and freight; 3) routine maintenance/inspection of aircraft; 4) major aircraft (airframe and powerplant) overhaul; 5) passenger reservation and cargo routing operations; 6) air traffic control flight operations; and 7) in-flight operations including piloting and avionics control/communications. Each of these areas requires specialized equipment, which entails training in its use and continued maintenance. The emphasis in this chapter is on large commercial (mostly international) operations although the discussion touches smaller civil aircraft, and civil helicopters. Aircraft sales to the region are covered, particularly as they relate to technical services, training, and spare parts availability and to U.S. policy issues such as official financing and export controls. Military aircraft sales and servicing are explicitly excluded, but the analysis does clarify the limited utility of commercial aircraft and related services for military uses.

Compared to other technologies covered in this study, technology absorption has been extensive in the commercial aircraft support sector. Operating statistics of these airlines (including safety) are comparable to those of major international airlines. This chapter analyzes the reasons for this comparative success.

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[1] The average age of nonjet aircraft in the Middle East is 5.0 years, compared to 13.7 years for such aircraft worldwide. For jet aircraft, the number is 8.2 years, and the world average 9.5 years.

[2] The sum of the products obtained by multiplying the number of tonnes (1 tonne = 1,000 kg) of revenue load carried by the flight distances measured in kilometers is the number of revenue tonne-kilometer performed. Separate calculations are made for passengers (including baggage), freight (including express), and mail.

[3] Robert Bailey, "Boeing Strikes Back," *Middle East Economic Digest*, Feb. 3, 1984, p. 35.

The analysis makes it clear, however, that while indigenous personnel in the Middle East are increasingly operating commercial aircraft support systems, some airlines may never become fully staffed by nationals.

The United States is an acknowledged leader in avionics and aircraft engines, but adequate substitutes are increasingly available from other supplier countries. U.S. aircraft sales in the Middle East region, important to sales of auxiliary equipment and services, have been negatively affected by U.S. foreign policy controls on exports. The European Airbus consortium[4] on the other hand has expanded sales in the region, and, to prevent future loss of sales, has even considered recertifying the Airbus with British Rolls-Royce engines instead of its present U.S. origin Pratt and Whitnèy or G.E. engines in order to avoid possible delays arising from U.S. export licensing procedures. Some U.S. observers feel that U.S. companies are also disadvantaged by subsidies which the Airbus receives from its European partners, and by a comparative lack of high-level diplomatic support. This view, however, is not shared by the Europeans who feel that U.S. aircraft sales are subsidized by U.S. Export-Import Bank and indirectly by NASA research programs.

All Middle Eastern countries under study have national airlines, but few turn a profit. Some, such as Saudia, are presently heavily subsidized. In contrast, Gulf Air, a consortium of several Middle East countries,[5] has been profitable even during the recent recession period, despite its tragic crash in 1983.[6]

This chapter analyzes commercial aircraft support systems technology transfer to the Middle East. First, requirements for commercial aircraft support are identified and their status is surveyed in the six countries under study. The technologies include a broad spectrum of application and complexity, but tend to be well established and governed by international norms. Recipient perspectives are then reviewed, focusing on development plans in this technology sector and their absorption of the technologies. Most of the countries under study have placed great emphasis on transportation needs, particularly civil air transport (passenger and freight) requirements. Plans include construction of new airports, expansion of existing airports so that they can accept larger aircraft and international traffic, and increased personnel training facilities. Experiences with technology absorption have varied, but capabilities have been improved at a rapid rate over the past 10 years, particularly in in-flight operations and passenger reservation and cargo routing. Although aircraft routine maintenance and major overhaul work is increasingly performed by the airlines themselves, many of the workers are expatriates and, in Saudi Arabia and Kuwait, will probably remain so for some time. The chapter also analyzes competition among suppliers. Likely short- and long-term developments for the recipient nations and for the suppliers are then described, and finally implications for U.S. policy are given. One important issue addressed is the role of U.S. export controls in affecting competition among suppliers.

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[4] Members are Aerospatiale of France (37.9 percent ownership), Deutsche Airbus of Germany (37.9 percent), British Aerospace (20 percent), and Construcciones Aeronautics of Spain (CASA) (4.2 percent).

[5] Bahrain, Qatar, Oman, and the UAE.

[6] The Gulf Air crash of a Boeing 737 near Abu Dhabi on Sept. 23, 1983, with a loss of 111 lives is still being investigated.

COMMERCIAL AIRCRAFT SUPPORT SYSTEMS IN THE MIDDLE EAST

COMMERCIAL AIRCRAFT SUPPORT SYSTEMS

Commercial air transportation systems consist of two interdependent components: first, airline operations (including maintenance and operation of aircraft); second, airport and aviation support services (e.g., air traffic control) provided by an outside agency, usually governmental. In both, equipment ranges from the simple to the very sophisticated.

Labor and capital requirements differ between the two components of the air transportation system. The operation of aircraft is highly capital intensive, with small flight crews operating very expensive equipment to serve large numbers of customers. Ground operations, by contrast, are far more labor intensive since they use less expensive equipment but employ large labor forces to service and turn around aircraft in the shortest time possible.[7]

The occupational structure of air transport is consequently very diversified. Airline personnel range from low skill level (clerks, baggage handlers) to very high skill level (managers, pilots, mechanics, air traffic controllers). Air transport requires labor mainly in the clerical, professional, craft, and service categories. One key occupational group is present in each category—namely, ticket agents, pilots, mechanics, and flight attendants. Each occupational group has its own very specialized training requirements.[8]

The operations of airlines also depend on the aircraft manufacturing industry. While none of the Middle Eastern countries under study have civil aircraft manufacturing facilities, Egypt is presently manufacturing military aircraft of U.S. design.[9]

The high costs of purchasing and operating modern aircraft are dominant factors in the financial positions of airlines; in the United States, direct flying operations, maintenance of aircraft, and depreciation make up over half the total expense of airlines. A new McDonnell Douglas DC-10 in 1980 cost about $60 million,[10] and the ratio of the capital value of flight equipment to ground equipment owned by U.S. airlines was more than 4:1 in 1980.

These high aircraft costs affect labor requirements in two ways: first, flight operations themselves are very capital-intensive. With a trend towards larger aircraft in the 1960's and 1970's, there has been a tendency to use smaller flight crews serving larger numbers of passengers. Second, the high cost of aircraft on the ground puts a premium on rapid turnaround so as to keep the aircraft flying.

Labor represents the single largest cost item for airlines worldwide, with nearly 10 percent of the work force being cockpit crew.[11] In the airline industry, labor is highly skilled and must assume a high degree of responsibility.

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[7] According to the U.S. Civil Aeronautics Board, flying operations made up 39 percent of the expenses of the U.S. airline industry in 1980. Expenses for other subsectors included (in percent): maintenance—10.8; passenger service—9.4; aircraft and traffic servicing—16.4; general and administrative—3.9; promotion and sales—12.1; and depreciation, amortization, other—8.4. See U.S. Civil Aeronautics Board, *Air Carrier Financial Statistics*, March 1980.

[8] In the United States, the occupational breakdown for the air transport industry includes: professional and technical, 19 percent (including pilots); clerical, 30 percent; craft workers, 20 percent (including aircraft mechanics); service workers, 14 percent; laborers, 4 percent; managers, 6 percent; operatives, 6 percent; and sales, 1 percent. U.S. Bureau of Labor Statistics, Washington, D.C., 1981.

[9] Mark Lambert, "Egypt Rebuilds Its Aircraft Industry," *Interavia—Aerospace Reviews*, February, 1984, pp. 157-60.

[10] Aircraft prices vary considerably, depending on plane configuration and customer needs for training and spare parts. For example, a Boeing 747 in 1984 reportedly ranged in price from $77 million to $84 million (747-SP) to $91 million to $106 million (747-300 extended).

[11] Labor and fuel are the two largest cost categories in the industry worldwide. See William E. O'Connor, *An Introduction to Airline Economics* (New York: Praeger, 1982). Cost per gallon of jet fuel for U.S. air carriers increased from 12.7/gal. in 1973 to 57.8/gal. in 1979 to 104/gal. in 1981, and dropped slightly to 98.1/gal. in 1982. Cost of fuel as percent of cash operating expenses moved from 12.2 percent in 1973 to 28.1 percent in 1982. Aerospace Industries Association of America, Inc., *Aerospace Facts and Figures—1983/84*, Washington, D.C., July 1983, p. 86. Cost of fuel for airlines in the Middle East depends on refining capabilities and subsidies of the individual countries.

Major Components of Commercial Air Transportation Systems

A. Airline Operations

1. Aircraft operations (usually called "flying operations"): the actual flying of aircraft from one point to another. Consumes fuel and employs a flight crew (consisting of cockpit crew and cabin crew.
2. Maintenance: periodic maintenance of aircraft while *out of service.* Uses spare parts and maintenance facilities and employs aircraft mechanics and related personnel.
3. Aircraft and traffic servicing: servicing aircraft during operations, securing aircraft at arrival and departure, loading and unloading cargo. Employs trained personnel such as baggage handlers, tug drivers used to move the aircraft on the ground, and aircraft service personnel.
4. Passenger service: ticketing, information, passenger facilities at airports, food served to passengers in flight, and related services. Uses airport facilities and supplies and employs service personnel and support personnel such as food preparers (the latter often employed by an outside vendor rather than the airline).
5. Administration: general management, accounting, and related business functions. Employs management personnel and office support staff.
6. Promotion and sales: advertising, publicity, travel agent commissions, and other promotional activities. Employs public relations/advertising staff and support personnel.

B. Airport Operations

7. Airport facilities: construction, maintenance, and operations of airport facilities. Employs primarily service personnel, management and support staff. Construction of a new airport requires major commitment of design/planning and construction labor. Within airport operations are included many subsidiary businesses and concessions including restaurants, duty-free shops, and book stores.
8. Food service: provision of food for passengers and other customers, both in the airport and in flight (the latter being included above under "passenger service"). Employs food preparation and service personnel.
9. Hotel service: airports generally spawn a local hotel industry, both on the airport grounds and in the surrounding area. Hotels serve both passengers and airline personnel, and may also be conference centers.
10. Fuel service: provision of fuel for aircraft. This involves pipeline and storage facilities, management of the fuel system, and actual fueling of aircraft (the latter included under "aircraft servicing" above).
11. Ground transport: transportation of people and goods to and from the airport is a major aspect of airport operations. Personnel include taxi and bus drivers, rapid transit personnel, and support staff.
12. Air traffic control: generally handled by a governmental aviation authority and consisting of three sectors—control of movement of aircraft taxiing on the ground (ground control), control of takeoffs and landings (tower), and control of aircraft movement while in the air between airports (air traffic control). Requires very highly trained professional staff, operating sophisticated equipment (radar, computers, communications equipment).

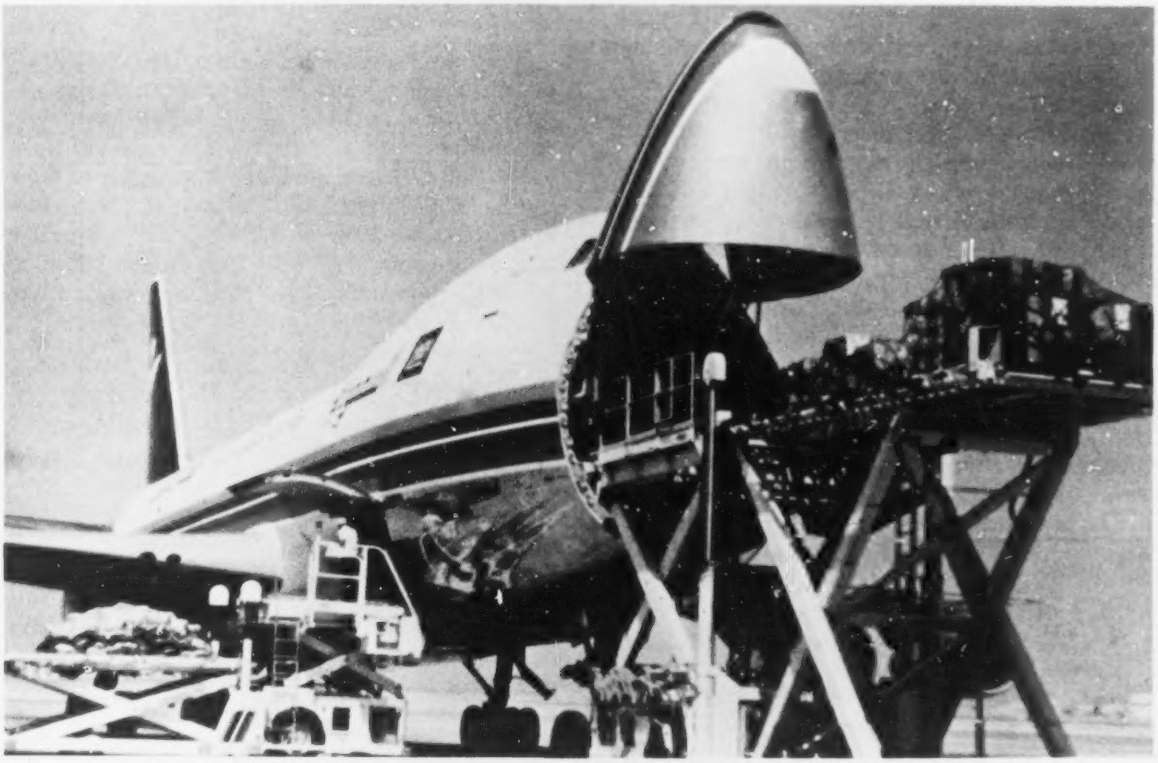

Photo credit: Saudi Arabian Ministry of Commerce

Ground-loading operations for Saudia Airlines

Strict standards in employee selection and training are essential.

Ground operations by the airlines also require considerable training. Aircraft servicing and maintenance require specific skills and training, as does passenger service to a lesser extent. Cargo and baggage handling may appear to be the least skilled aspect of ground operations, but in fact skill is required to safely handle shipments in international service which on average weigh 600 pounds. Security personnel are also a vital part of the ground operations since air cargo in storage and transit is particularly vulnerable to theft.[12] The pressure to turn aircraft around rapidly and the need to meet peak demands, add to the labor-intensity of the ground operations.

COMMERCIAL AIRCRAFT SUPPORT SYSTEMS IN THE MIDDLE EAST: CURRENT STATUS

During recent years, the Middle East/Far East route with a load factor of 65 percent has experienced the highest passenger growth (22 percent) of all IATA (International Air Transport Association) route areas worldwide.[13] The Europe/Middle East routes remained at 1981 levels, however. Saudia ranked 17th in scheduled tonne-kilometers performed in 1982 of all 121 IATA members and had a 22.8 percent growth rate from 1981 to 1982. Kuwait Airways had a 20 percent growth rate in tonne-kilometers from 1981 to 1982. Saudia ranked 15th among the 121 IATA members in scheduled passenger-kilometers[14] in 1982 with 12,277 million.[15] Saudia now ranks among the major international carriers, as shown in table 62. According to IATA and ICAO data, operating statistics for these six airlines in the Middle East such as revenue passenger load factor, average daily aircraft utilization, and safety are comparable in most cases to those of other national flag carriers operating internationally. Also shown in table 62 is the fact that these airlines increased operations during 1982 while several airlines from other regions of the world experienced decreased operations.

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[12] O'Connor, op. cit., 1982, p. 126.

[13] The average load factor worldwide in 1982 was 64.2 percent.

As another indication of the relative size of the airlines, table 63 gives employee totals for several airlines in 1982. Saudia airlines is by far the largest air carrier of the six study countries with total personnel numbering close to that of TWA or Japan Air Lines. The number of in-flight personnel of Saudia, however, is much lower than that of the non-Middle Eastern airlines listed. Iraqi Airways, with 4,863 total personnel, is the smallest airline included in the tabulation.

Table 64 includes airport traffic statistics for representative airports in the Middle East and the United States. Although not all international airports existing in these countries are listed in the table, relative traffic volumes can be noted. Bahrain, Qatar, and the United Arab Emirates (UAE) are included in the list since they carry significant air traffic in the region. Major international and domestic airports in the Middle East are shown in map 5.

Descriptions of the airlines of the six countries under study are given in more detail below. As a reference, relative sizes of several of the commercial airline fleets in the Middle East are given in table 65.

Saudi Arabia

Saudia, the national airline, has the greatest number of route miles of all national airlines covered in this study and has surpassed the beleaguered Middle East Airlines of Lebanon. Saudia has a fleet which includes 12 Boeing 747s, 17 Lockheed TriStar L-1011s, 9 Boeing 707s, 20 Boeing 737s, and 11 smaller planes. Saudia ordered 11 Airbus A300's to be delivered during May through September 1984.

TWA and Saudi Arabia have been associated in civil aviation since 1945 when President Roosevelt gave a DC-3 to Saudi Arabia's King Saud. The first contract was signed in 1946 between TWA and Saudi Arabia with subsequent ones through 1984. TWA participated extensively in the management and operations of the airline in the early period, but since 1979 its involvement has decreased markedly. With the new 1984 contract, the Saudis have taken over management of the airline. A successful program of training and upgrading of facilities and personnel led to gradual "Saudization" of the work force even while the company was expanding at a faster rate than any other national airline in the world. During the 1970's, Saudia had neither sufficient fleet nor personnel and facilities to accomplish the task of moving foreign workers in and out of the country. The main airports at Jeddah, and Riyadh especially, used aged facilities designed for the DC-6 era. Temporary airport buildings were rushed to completion within 18 months and by late 1976 the airline began to lease aircraft and integrate them into operations on a temporary basis. Some leased aircraft, mostly Boeing 747s and Douglas DC-8s, still are being used, usually during the annual Haj pilgrimage.[16]

Saudi Arabia is continuing its large-scale airport expansion projects which include both international and domestic airports. Eleven domestic airports will be upgraded to handle increased passenger traffic at a cost of approx-

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[14] Scheduled passenger-kilometers is the sum of the products obtained by multiplying the number of passenger seats scheduled by flight distances measured in kilometers.

[15] International Air Transport Association, *World Air Transport Statistics*, No. 27, 1982.

[16] The Haj is the pilgrimage of Muslims from all over the world to Mecca, located in Saudi Arabia.

Table 62.—Operating and Performance Statistics of Selected Airlines for 1982

Country	Airline	Passengers		Tonne-kms performed		Available tonne-kms		Load factor	
		000s	± change	Millions	± change	Millions	± change	Passenger	Weight
Saudi Arabia	Saudia	10,060	41.9%	1,478	22.8%	3,047	12.4%	64.2%	48.5%
Kuwait	Kuwait Airways	1,461	16.6	456	19.9	849	6.7	65.7	53.6
Egypt	EgyptAir	2,433	9.2	395	14.1	702	2.6	60.3	56.3
Algeria	Air Algérie	Not reported							
Iran	Iran Air	2,009	30.5	215	15.7	352	22.0	67.3	61.6
Iraq	Iraqi Airways	481	5.2	187	12.7	388	20.3	59.3	48.2
United States	TWA	17,854	−1.6	4,429	−1.5	8,149	−2.1	63.9	54.3
United States	Eastern Airlines	35,500	−1.4	4,334	−1.0	8,014	−2.5	57.7	54.1
United Kingdom	British Airways	14,838	−3.1	4,310	−6.4	6,827	−6.9	67.4	63.1
France	Air France	11,584	0.2	4,218	1.8	6,765	3.8	64.1	62.3
Federal Republic of Germany	Lufthansa	12,775	−1.5	3,746	4.4	6,317	8.5	59.6	59.3
Japan	Japan Airlines	13,329	−4.4	4,993	3.2	8,125	−4.6	62.5	61.4
Total[a]		384,610	−0.9%	87,529	0.4%	152,901	−0.3%	62.0%	57.2%

Note: ± is percent change from previous year data.

[a] Total industry value for IATA Members in 1982 based on approximately 121 IATA member airlines.

SOURCE: International Air Transport Association, *World Air Transport Statistics*, No. 27, 1982.

Table 63.—Employee Totals for Representative Airlines, 1982

Country	Airline	Pilots and copilots	Other cockpit personnel	Cabin attendants	Maintenance and overhaul personnel	Ticketing and sales personnel	Traffic-handling personnel	All other personnel	Total	
									Number	± change over 1981
Saudi Arabia	Saudia	670	216	2,671	4,014	2,626	5,437	8,096	23,730	5.7%
Kuwait	Kuwait Airways	174	76	487	1,808	1,139	734	2,113	6,531	4.9
Egypt	EgyptAir	251	81	633	1,981	—	—	6,537	10,731	4.2
Algeria	Air Algérie	Not reported								
Iran	Iran Air	193	81	721	1,378	882	2,253	4,027	9,535	−2.7
Iraq	Iraqi Airways	136	120	330	1,958	390	478	1,451	4,863	4.3
United States	TWA	1,802	971	4,905	7,051	3,752	7,739	3,024	29,244	−4.3
United States	Eastern Airlines	2,839	1,212	5,987	10,228	5,036	10,324	4,325	39,951	−0.7
United Kingdom	British Airways	2,104	447	4,375	9,009	3,376	8,943	9,700	37,954	−15.8
France	Air France	1,320	771	4,239	8,767	—	—	—	34,537	2.8
Federal Republic of Germany	Lufthansa	1,564	562	3,938	8,353	4,361	6,603	5,331	30,712	0.1
Japan	Japan Air Lines	1,355	646	5,132	4,951	3,575	3,449	2,632	21,740	0.9

SOURCE: International Air Transport Association, *World Air Transport Statistics*, No. 27, 1982.

Table 64.—Airport Traffic Statistics for Representative Airports (1981 unless otherwise noted)

State City Airport	Aircraft movements (000)	Passengers (000 embarked and disembarked)			Freight (000 of tonnes)			Mail (000 of tonnes)		
	Commercial air transport	Total	International	Domestic	Total	International	Domestic	Total	International	Domestic
Saudi Arabia:										
Jeddah[a]										
Jeddah International	87.5[b]	7,505	3,499	4,006	47.8	35.0	12.8	NA	NA	NA
Kuwait:										
Kuwait[c]										
Kuwait International	27.3	2,376	2,376	0	55.1	55.1	0	2.2	2.2	0
Egypt:										
Cairo										
Cairo International	51.8	5,239	4,741	498	56.8	56.3	0.5	NA	NA	NA
Algeria:										
Algiers										
Dar El Beida	40.1	2,870	1,520	1,350	32.2	28.4	3.8	NA	NA	NA
Iran:										
Teheran										
Mehrabad International	15.8	1,689	283	1,406	39.1	33.7	5.4	1.7	1.6	0.1
Iraq:										
Baghdad										
Baghdad International	6.3	618	618	0	16.7	16.7	0	0.5	0.5	0
Bahrain:										
Bahrain										
Bahrain International[a]	38.2	1,588	1,588	0	17.4	17.4	0	1.5	1.5	0
Qatar:										
Doha										
Doha International	15.6	662	662	0	16.7	16.7	0	0.5	0.5	0
U.A.E.:										
Abu Dhabi										
Abu Dhabi International[a]	34.7	924	899	25	26.1	NA	NA	NA	NA	NA
United States:										
Washington, D.C.										
Dulles International	29.2	2,133	377	1,755	23.2	11.4	11.8	17.9	2.3	15.7
United States:										
San Francisco, Calif.										
San Francisco International	268.6	19,848	2,170	17,678	317.9	NA	NA	105.1	NA	NA
United States:										
Philadelphia, Pa.										
Philadelphia International	255.6	9,009	468	8,540	93.3	8.9	84.3	45.9	0.5	45.5

NOTE: Totals may not add up due to rounding.

[a] 1980 statistics. Complete data not available for the King Abdul Aziz airport, but later 1981 data imply a rate of over 100,000 total commercial air transport movements per year.

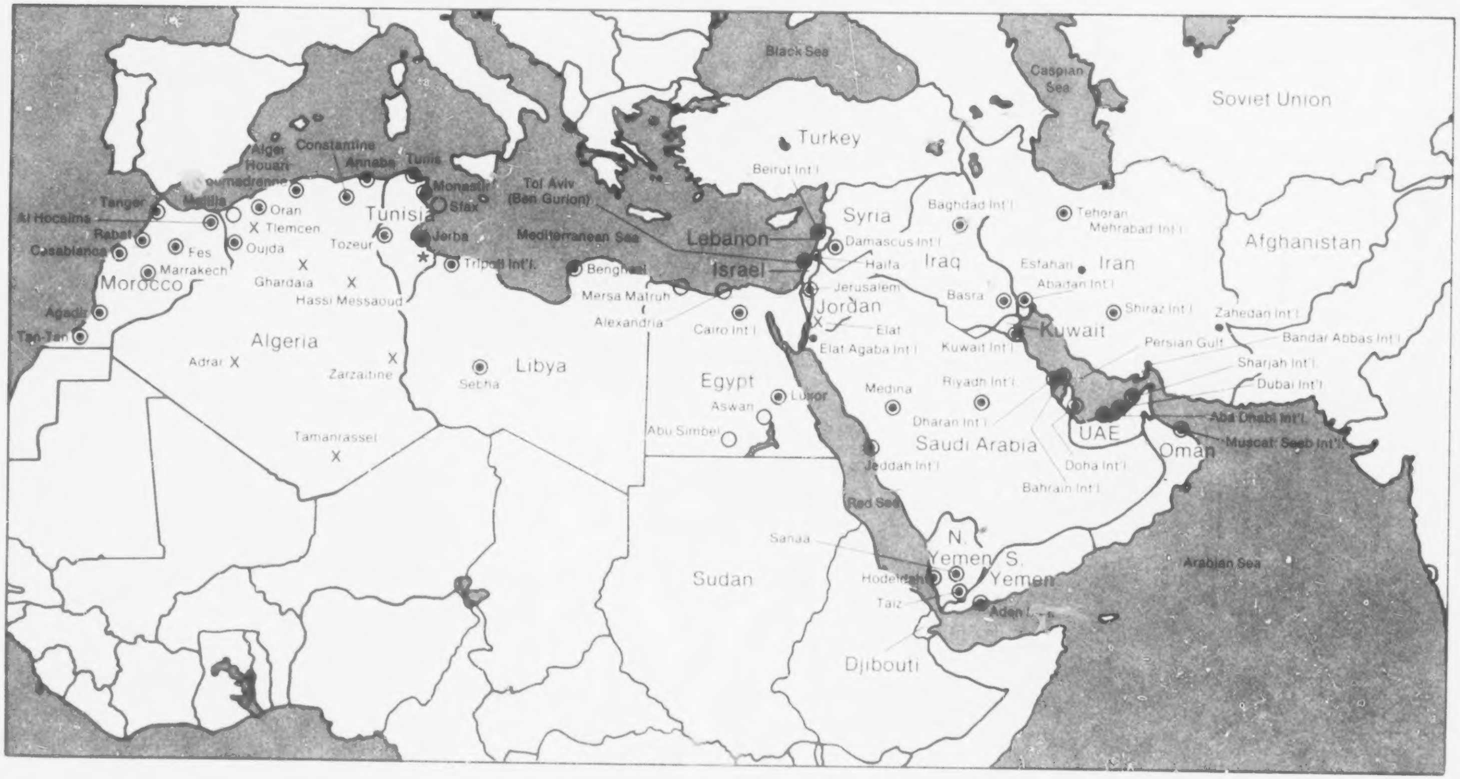
[b] 1978 data point.

[c] Kuwait as a city-state has no domestic air services.

NA—not available.

SOURCE: International Civil Aviation Organization, *Airport Traffic—1981, Digest of Statistics No. 287*, 1982.

Map 5.—Airports in the Middle East and North Africa



Key

◉ Airports required for regular use by international scheduled air transport

● Airports required for alternate use by international scheduled air transport

X Airports required for regular use by international non-scheduled air transport

★ Airports required for alternate use by international non-scheduled air transport

○ Airports required for regular use by international general aviation

NOTE: The delineation of boundaries on this map must not be considered officially accepted. Geographic names or their spellings do not necessarily reflect recognition of the political status of an area.

SOURCE: Office of Technology Assessment, taken from *Air Navigation Plan: African-Indian Ocean Region*, Department of Commerce ICAO DOC 7474/23, August, 1980 and *Air Navigation Plan: Middle East and Asia Regions*, Department of Commerce ICAO DOC 8700/13, August, 1982.

Table 65.—Commercial Airline Fleets in the Middle East in Service as of March 1984 (on order as of March 1984 in parentheses)

		Boeing						Douglas	Lockheed	Airbus		
Country	Airline	707	727	737	747	757	767	DC8	L1011	A300	A310	A320[a]
Saudi Arabia	Saudia	9	—	20	12	—	—	6[b]	17	(11)		
Kuwait	Kuwait Airways	7	4	—	4	—	—			(3)	3(5)	
Egypt	EgyptAir	6		7			(3)[c]			8		
Algeria	Air Algérie		11	13						2[d]		
Iran	Iran Air	5	10	4	10					6		
Iraq	Iraqi Airways	3	6	3	4							
Bahrain, U.A.E., Oman, Qatar	Gulf Air			9					8			
Lebanon	Middle East Airlines	7[e]		3							(5 plus 14 options)[f]	
Libya	Libyan Arab Airlines	4	10							(6)	(4)	
Jordan	ALIA	5	6	3					5			
Syria	Syrianair		3		2							
Cyprus	Cyprus Airways	4									1(2)	(4 plus 4 options)
Totals (existing and firm order)		50	45	59	35	0	(3)	6	30	16(20)	4(16)	(4)

[a] The development funds for the Airbus A320 were approved by the consortium in March 1984.
[b] Leased from Overseas National and Icelandair.
[c] These three Boeing 767 extended range versions due to be delivered July 1984.
[d] Leased from Lufthansa.
[e] MEA previously had 18 707s (IATA, WATS 1982) but 6 were destroyed and 5 extensively damaged in the Lebanon conflict.
[f] These may have been canceled, although the contract has not been formally abrogated, according to the *Middle East Economic Digest*, Feb. 3, 1984, p. 35.

SOURCE: Taken from Exxon International Co., *Air World Survey—Turbine-Engined Fleets of the Worlds' Airlines 1983*, Florham Park, N.J., and OTA communications with Boeing Commercial Airplane Co., Renton, Wash., and Airbus Industrie, N.Y., March 1984. Note that "firm orders" for a particular jet and "options" in particular can be fairly volatile numbers. The 707, 727, DC8, and L1011 are no longer in production.

imately $295 million.[17] At five airports (Medina, Gassim, Gizan, Abha, and Tabouk) the expansion is designed to accommodate wide-body jets (Lockheed TriStar and Airbus) which will be equipped to meet the highest international navigational standards. At the smaller airports, the projects are designed to accommodate Boeing 737 aircraft instead of Fokker F28s. These airport projects in rural areas were originally tendered in 1983. However, in 1984 it was reported that the Presidency of Civil Aviation (PCA) was retendering these domestic airport expansion projects in order to economize on expenditures.[18]

Saudi Arabia's major international airports consist of: Dhahran International, Jeddah International, and Riyadh International. Presently, only Saudia calls at King Khalid International Airport (KKIA) at Riyadh, but KKIA will soon open to international carriers according to Civil Aviation President Sheikh Nasser Al-Assaf.[19] Pan American Airways and Saudia presently operate a joint service between New York and Dhahran. Saudia also now flies to New York from Jeddah. Foreign carriers which serve Jeddah or Dhahran include Alitalia, Air France, British Airways, Lufthansa, Middle East Airlines, and Iran Air. Some 44 airlines now fly into Saudi Arabia, and Saudia flies to major European, North African, Arab, and South Asian cities.

Riyadh's King Khalid International Airport was completed in 1983 at a total cost of about $3.2 billion. It began receiving commercial flights on December 5, 1983.[20] The airport was designed to handle 7.5 million passengers in its first year while it was still in the first stages of initiating its operations. The number will reach 18 million passengers annually by the year 2000.[21]

Servicing the pilgrimage, with its 800,000 visitors, more than 70 percent of whom travel in and out by air, is the second most important task for Civil Aviation, after supplying facilities for national needs. During the 45- to 60-day period preceding and following the Haj pilgrimage period to Mecca each year, the traffic density at Jeddah airport approaches that of some of the busiest U.S. airports, such as O'Hare in Chicago. Hundreds of charter flights, many by airlines not normally servicing the Kingdom, must be guided to safe landings and their airplanes serviced rapidly. It is a unique problem, and the Saudis have increased their use of modern computer techniques both to handle the aircraft and the pilgrims themselves. The Jeddah airport in its design and operations thus represents adaptation of commercial aircraft support systems to local requirements.

Egypt

Cairo is among the most active air centers in the Middle East and is served by a number of international air carriers. Egypt's one international airport is located in Cairo. Facilities at the Cairo airport are to be expanded to handle a projected fourfold increase in passenger traffic and rapidly increasing air freight tonnage. Alexandria's El-Nouzha Airport, located on the eastern outskirts of the city, resumed scheduled operations for domestic flights in late 1980. The airport has two operational runways, one of which will be lengthened to accommodate international flights.

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[17] *Saudi Business*, Oct. 16-27, 1982, and Oct. 23-24, 1982; *Saudi Report*, Nov. 29, 1982.

[18] It is also believed to be the first case of a retendering prompted by King Fahd's recent decree that all government tenders must be announced publicly. "Airport Expansion Projects To Be Retendered," *Saudi Business and Arab Economic Report*, No. 6, May 28, 1983, reported in JPRS, Near East/South Asia, June 30, 1983. It is reported that Saudi Arabia may revise a portion of its ambitious airport modernization program because of anticipated cuts in government spending due to decreased oil revenues. This is not, however, expected to stop any of the large construction or upgrade plans included in the latest phase of airport modernization, but it may result in a scaling down of certain programs, such as those in the Eastern Province. See Jeffrey M. Lenorovitz, "Slack Oil Funds May Force Saudis To Cut Airport Plans," *Aviation Week and Space Technology*, May 21, 1984, pp. 41-45.

[19] Tony Odone, "KKIA: Beginning a New Phase in Saudia Arabia," *Middle East Economic Digest*, Nov. 11, 1983; *Saudi Report*, Nov. 29, 1982.

[20] Jim Bodgener, "U.K. Airlines Battle for KKIA Rights," *Middle East Economic Digest*, Sept. 11, 1983, p. 38; Jan. 27, 1984, p. 26.

[21] "King Fahd Opens the King Khalid International Airport: A Tour Through Riyadh's New Airport, Which Is One of the Biggest in the World," *Al-Majallah*, No. 196, Nov. 12-18, 1983, pp. 18-21, as reported in JPRS, Near East/South Asia, Jan. 30, 1984.

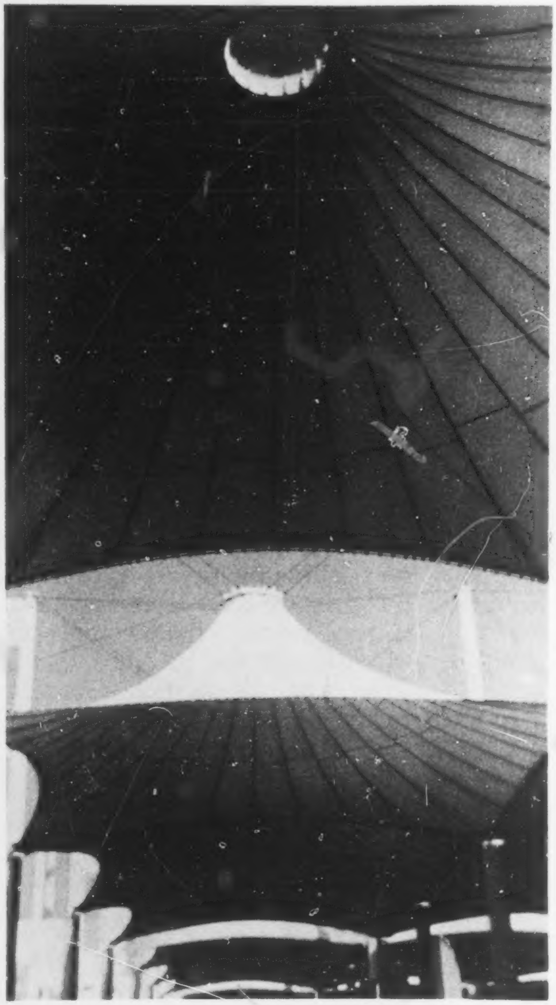

Photo credit: Aramco World Magazine

Haj Terminal, King Abdul Aziz International Airport, Jeddah, Saudi Arabia. The roof structure is evocative of bedouin tents

The national airline, EgyptAir, has six 707s (plus two more leased), seven 737s, eight Airbus A300s, two Fokker F-27s (leased), and two Cessnas.[22] EgyptAir (formerly United Arab Airlines) has been operating since 1931. It provides flights to about 40 cities in Europe, Asia, Africa, and the Middle East. The airline is considering the creation of an all-cargo subsidiary. A private cargo company, International Air Cargo Corp., was formed in early 1977.[23]

Algeria

Algeria has a relatively good transportation network and is devoting substantial resources to its expansion and modernization. Algeria's international airports consist of Dar el Beida in Algiers, Annaba, Ain-el-Bey in Constantine, and Es Senia in Oran. Other major airports are located in Bechar, Hassi Messaoud, In-Salah, Tamanrasset, and In-Amenas. Fifty-five smaller airports are located across the country.

Air Algérie, the state-owned and operated airline, continues to expand its international services. At the end of 1981, Air Algérie was operating a record 250 scheduled domestic flights weekly, for cargo as well as passengers.[24] Its fleet consists of 11 Boeing 727s, 13 Boeing 737s, and 3 Lockheed Hercules aircraft as well as 42 Beechcraft and Grumman aircraft for crop spraying, pipeline surveillance, and other purposes. Most of the equipment in Algerian civil aviation is made by U.S. firms,[25] although Air Algérie leases two Airbus A300s from Lufthansa.

The leading foreign suppliers rank ordered by total sales in 1979-82 were the United States (aircraft and engines, $165 million), India, Belgium, and Hungary. By total expenditures since 1979, civil aviation projects ranked second for Algeria among the five technology sectors studied in this assessment ($265 million from 1979-82). This was a significant rise over the total value of contracts awarded during the 1972-78 period ($5.7 million). In addition, the absolute number of contracts approved in the later period was higher than the number approved in the earlier 1972-

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[22] International Air Transport Association, *World Air Transport Statistics*, No. 27, 1982; also personal communication, Airbus Industrie, New York, March 1984.

[23] U.S. Department of Commerce, *Overseas Business Reports*, OBR 81-31, "Marketing in Egypt," December 1981.

[24] U.S. Department of Commerce, *Foreign Economic Trends, Algeria 1982*, p. 11.

[25] Information provided by the U.S. Embassy, Commercial Section, Algiers, 1982.

78 period, reflecting the Algerian Development Plan's emphasis on transportation.

Kuwait

Kuwait, as a city state, has one international airport and no domestic airline routes. Its international airport has recently been expanded to handle 4 million passengers and 30,000 tons of cargo per year.[26]

Kuwait Airways, the national airline, has four 747s, seven 707s, four 727s and two Hawker Siddeley HS 125s. Kuwait Airways owns three Airbus A310s and has five more on order. Three Airbus A300s are also on order. This company has the fewest route miles of the six national airlines covered in this study. Kuwait Airways is an independent line item in the Kuwaiti budget; it is given a subsidy and capitalized as an extraordinary item. Operating losses in 1980 reached $33.3 million, reflecting the fact that flying expenses increased by 56 percent in 1 year, 1979-80, due partly to aviation fuel cost increases.

Passenger traffic grew between 1976 and 1980 by 45 percent, while freight traffic grew by 160 percent. The airline's capital has been substantially raised to permit purchase and amortization of the first six Airbuses scheduled to be delivered in 1984. In addition to Kuwait Airways, Kuwait is served by Gulf Air, Saudia, Iran Air, British Airways, Air France, KLM, and Lufthansa.

Iraq

Iraq's international airport is located in Baghdad. The first phase of the new Saddam Hussein Airport has now been completed, and as of 1980, work was underway on a new international airport at Basra. The present status of both these projects, however, is uncertain, due to the war with Iran. In the north, an international airport at Mosul is under design.[27]

Iraqi Airways presently has three 707s, six 727s, three 737s, and four 747s. Iraqi Airways ranked 44th out of 121 IATA members in 1982 international tonne-kilometers performed, but it grew 12.7 percent by the same indicator during the 1981-82 period.

Iran

Iran has international airports in Abadan, Esfahan, Teheran (Mehrabad International), Shiraz, and Zahedan. There are 36 major and secondary domestic airports open to civil aviation. Iran Air, the national flag carrier, was founded in 1962, taking over limited freight and passenger operations from two private companies. Its load factor grew appreciably, and in 1977 it served 25 different domestic airports and provided services in international routes to 24 different countries in North America, Europe, and East Asia. Iran Air has five 707s, ten 727s, four 737s, ten 747s, and six Airbus A300s. Iran Air ranked 50th out of 121 IATA members in 1982 scheduled tonne-kilometers performed and 49th in scheduled passenger-kilometers.

Regional Efforts

There are a number of regional efforts to develop commercial airlines and support systems in the Middle East. These include technical assistance programs, as well as one regional airline company, Gulf Air, which is jointly owned by four Middle Eastern countries.

Many technical assistance programs are being pursued with foreign participation. The U.S. Federal Aviation Administration (FAA), for example, is presently conducting technical assistance programs promoting the regional development of commercial aircraft support in the Middle East. These include assistance in design and development of the Kuwait International Airport, where the National Aviation System has two resident U.S. advisors. In Saudi Arabia, the FAA runs Saudi airman certification services for the Boeing 707/737/747 and the Lockheed L-1011. During the period 1951-82 the FAA trained over 550 personnel in the six countries under study in air traffic control, air navigation facilities, airport services, and flight standards.[28]

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[26] U.S. Department of Commerce, *Overseas Business Reports*, OBR-79-18, "Marketing in Kuwait," June 1979.

[27] Information provided by the U.S. Department of Commerce, International Trade Administration, Feb. 10, 1983.

AACO (Arab Air Carriers Organization) has attempted to organize an aircraft spare parts pool similar to those in Europe such as the ATLAS (Boeing 747) and KSSO (DC-10), but the results have been mixed. Saudia is the holder of L-1011 spares at Jeddah, but Lockheed spares are also stored in Amman, Jordan by TriStar Parts Ltd.[29]

The IATA Program for Developing Nations Airlines (PDNA) assists airlines in developing countries in funding for individual or joint airline projects and in arranging and coordinating consulting and airline training services.[30] A training seminar, sponsored jointly by AACO and IATA, was held in Amman, Jordan in April 1983. The basic purpose was to determine the specific training needs and priorities of airlines in developing countries and to establish the foundation for a comprehensive PDNA training program in the future. In addition, initial steps have been taken to explore the possibility of conducting detailed feasibility studies for a Regional Airline Training Center in Amman.[31]

ICAO also promotes civil aviation in developing countries worldwide. A major instrument in this work is the United Nations Development Program. So far, most of the organization's work in this area has been directed toward the development of the ground services required for civil aviation and in particular air traffic control, communications, and meteorological services. In the past few years, with the advent of larger and more complex aircraft, requests for assistance are increasingly in the more sophisticated fields of aviation. Assistance has been provided in the organization of government civil aviation departments and the location and operation of facilities and services, particularly personnel training. In Egypt and other Middle Eastern countries civil aviation training centers have been created or assisted.

Gulf Air is a joint venture between Bahrain, Qatar, the UAE, and Oman. Gulf Air was founded in 1950 as Gulf Aviation Co. and was nationalized in 1974 to become the flag carrier for the four countries.[32] It is now one of the region's largest passenger carriers, carrying numbers of passengers comparable to Iran Air and EgyptAir. After rapid expansion in the 1970's, the airline plans to consolidate certain operations in the 1980's and must cope with problems such as the worldwide trend toward fare deregulation, and overcapacity due to increased competition on Gulf routes. Overcoming difficulties which included lack of infrastructure and competent personnel, Gulf Air realized a small profit in 1979 which steadily increased to $10 million in 1980, $19.4 million in 1981, and $34 million in 1982.[33] Gulf Air has recently expanded its network somewhat. In 1982, it started flights to Amman, Jordan and Larnaca, Cyprus, reopened a link to Athens, and inaugurated a London-to-Cairo service. By the end of 1982 it was operating a fleet of eight Lockheed L-1011 TriStars and nine Boeing 737s.[34]

Historically, the dominant airline in the region was Middle East Airlines (MEA) of Beirut. It was largely responsible for making Beirut the hub of international air travel to the Middle East. In 1979, Lebanon began a

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[28] Quentin S. Taylor and J. Stuart Jamison, "FAA's International Training Programs," *Journal of Air Traffic Control*, October-Dececember 1982, pp. 6-9.

[29] These spare parts generally include only airframe line replaceable units, with engine parts inventories held elsewhere. Information provided by TriStar Parts Ltd., January 1983.

[30] See for example International Air Transport Association, "Consultancy and Training Services Directory," first edition, Nov. 1, 1981; "IATA—Improved Productivity Through Common Effort," August 1982; and "Wings for the Developing World," 1982. As stated by IATA, the basic objective of the PDNA is "for member airlines to develop self-reliance, thereby strengthening the global commercial air transport system."

[31] IATA Annual Report and Executive Committee Report, 1983, p. 24.

[32] "Gulf Air: Flying Against the Flag," *Middle East Economic Digest Special Report*, September 1981, pp. 41-43; and Dudley Nigel, "Gulf Air: A Servant of Four Masters," *Middle East Economic Digest*, Mar. 21, 1980, p. 10.

[33] Ibid.; and "Gulf Air's Profits Fly Against the Trend," *Middle East Economic Digest*, vol. 27, Issue 4, Jan. 28, 1983, pp. 8-9, and "Gulf Air Posted 34 Million Dollar Profit in 1982," An-Nahar Arab Report and Memo, vol. 7, Issue 27, July 4, 1983, p. 8.

[34] "Arab Airlines: Co-Operation in the Face of Competition," *Middle East Magazine—Aviation Survey*, August 1983.

$300 million program to expand and modernize Beirut airport, and in 1980 MEA announced its planned fleet expansion would include the purchase of five Airbus A310 aircraft, plus an option for 14 more. MEA survived the civil war of 1975 and the political instability in the late 1970's, but the 1982 war in Lebanon caused severe problems for the carrier. MEA lost six Boeing 707s and another five may be scrapped because of extensive damage. In addition, its ground facilities were damaged in the fighting. Insurance will provide only a small portion of the replacement costs, due to the restrictiveness of war risk coverage. The airline reportedly began to base its operations from Larnaca, Cyprus instead of Beirut. MEA does apparently plan to replace the aircraft lost and to continue its fleet modernization/expansion program based on the A310. The war has, however, eroded Beirut's position as a gateway, and MEA as a major factor in Middle East commercial aviation.

PERSPECTIVES OF RECIPIENT COUNTRIES AND FIRMS

Keeping an airline fleet operating is a technically demanding business. This section first outlines requirements for maintenance of commercial aircraft, reviews training programs associated with aircraft sales, and discusses the requirements such as airport design. Next, the experiences of six Middle East countries are analyzed in order to assess the extent of technology absorption and the significance of commercial airline support systems in their economic development programs.

Requirements for Commercial Aircraft Operation

Routine Maintenance.—Each aircraft model has a routine maintenance program for operation in scheduled service. Routine maintenance tasks consist primarily of inspection of the airframe, engines, systems and components to assure safety and satisfactory operation of the aircraft. Such routine maintenance is carried out by the individual Middle Eastern airlines.

Usually, these routine inspections or checks[35] are based on flight hours and are called Preflight, Transit, A, B, C, and Structural Inspection checks. The Pre-flight check is performed each morning prior to dispatch and anytime the aircraft is on the ground for more than 4 hours. The Transit check is performed before each flight, usually in a "walk-around" inspection. The flight crew can perform this check if maintenance personnel are not available. The A, B, C checks are called scheduled checks since they are performed at specific time periods. Each operator develops and obtains approval for his pattern of scheduled checks, but in broad terms the A check usually is performed approximately weekly (every 100 hours) with the B check interval four times that of the A (every 400 hours) and the C check interval four times that of the B.[36]

In order to avoid peaks and valleys in maintenance work and numbers of personnel, the checks are often combined into a "phase" check which consists of elements of all three checks, e.g., A + B/2 + C/8. There are many variations of these phases, normally established to correspond to a particular operational schedule.

Each inspection generates additional maintenance not part of the routine maintenance. A complete maintenance cycle includes these routine checks as well as major overhaul (structural inspection). Over the course of a complete maintenance cycle, nonroutine maintenance man-hours approximately equal the routine maintenance man-hours.

The number of personnel required depends on the type of check being performed and the length of time the aircraft is available for maintenance. The size of the aircraft also determines maximum crew size. The Boeing 747, for example, requires a maintenance crew approximately twice the size of that required for the 737. While a Pre-Flight or Transit check can be performed with as few as three to five people, a Phase (or C check) could require up to 50 people (for a 747) or 25 (for a 737).

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[35] The maintenance check is defined as a maintenance action requiring thorough examination of an item, component, or system for general condition with emphasis on proper attachment, safety wiring, cotter pins, fasteners, clamps, latches, tubing, plumbing, electrical wiring and connections, linkages, bearings, alignment, clearances, lubrication, obvious damage cracks, delamination, fraying, operating pressures, fluid leakage, excessive wear or play, corrosion, evidence of overheating, rubbing, aging, preservative coating or finish, cleanliness, and general appearances.

[36] The Structural Inspection (or airframe overhaul) is usually performed at intervals 10 times that of the C check, or, in the example noted—16,000 hours. Major overhaul is discussed below.

Crews must include personnel skilled in airframe and systems, powerplant, electrical, avionics, sheet metal, and interiors. These personnel must include some who are licensed to work on and, particularly, to signoff work for release of the aircraft to operations. Crew composition for a scheduled maintenance crew should be approximately 50 percent airframe and system mechanics, 20 percent engine specialists, and the remainder equally divided among electrical/electronic, radio, instruments, sheet metal, interior, and quality control specialists. Additional specialists from the operator's maintenance shops are utilized on an "as-required" basis on airplane checks. The suggested ratio of licensed personnel to skilled is approximately 1 to 3.

Each operator, if purchasing an aircraft from a company such as Boeing or Airbus, receives information in the form of documentation, complete drawings and verbal briefings, as to the ground support equipment required to maintain the airplane. The specifications and/or engineering drawings of equipment required to maintain a particular aircraft model are supplied to the buyer as part of the sales package. The buyer can purchase equipment through the seller, from outside sources, or can manufacture the equipment. Availability of equipment or manufacture of equipment at a particular operator's maintenance base depends entirely on the industrial capabilities of the local area. In most areas in the world, there are local industries capable of manufacturing the required equipment. Provisioning of equipment, whether through the aircraft seller, or from other sources, is a separate negotiation. A potential customer can include these costs in the total package.

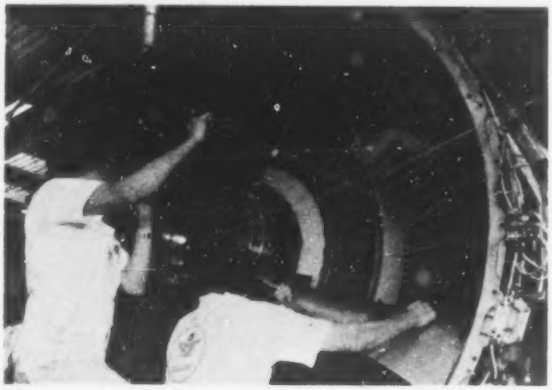

Photo credit: Saudi Arabian Ministry of Commerce

Jet turbine engine repair

Maintenance provisions and their costs can be very important in making an aircraft sale. Equipment investment forecasts are performed regularly for presentation to potential customers. Since spares and ground support equipment investment and maintenance costs comprise about 20 to 25 percent of an airline's operating costs, improvements in methods of maintenance, extensions in maintenance schedules, and reductions in numbers of special tools and equipment required are factors influencing sales. Over the life of an airplane, spare parts sales can easily equal the purchase price of the airplane. Efficient management of spare parts inventories has become increasingly important, due to the high costs of maintaining excessive stock and the long leadtimes required for obtaining certain aircraft parts.

Major Overhaul.—Major overhaul is costly and technically demanding. A fleet of approximately 15 airplanes is normally required to justify establishing an overhaul center, but there are many other considerations such as fleet composition, age, and engine types. The only major overhaul center presently in the Middle East is in Saudi Arabia. Despite attempts to establish a regional center, such a facility has not been set up, and seems unlikely in the near future.

A major overhaul of an aircraft is usually considered to be a structural inspection, during which the airplane is moved into a hangar with built-in work stands (or docks) which allow access to all areas of the airplane. The aircraft is lifted on hydraulic jacks high enough to allow landing gear retraction and extension. The interior furnishings (seats, galleys, and lavatories) are removed and interior wall and ceiling paneling and insulation are taken out. Components are removed, serviced, or repaired as required.

Personnel required to staff a major overhaul center include those skilled in engineering, training, production planning, quality control, spares planning and procurement, and shop personnel skilled in many different functions, such as electronics, welding, instruments, nondestructive testing, sheet metal, machining, and plastics repair. A total of approximately 450 people is required to staff such a maintenance base.

Guidelines for major overhauls in the United States are established by the FAA, and these guidelines are also used in the Middle East region.[37] Frequency of major overhaul depends on the operator's approved maintenance schedule and on flight hours. Boeing recommends a major overhaul at 16,000 flight hours for the 737 airplane. A structural inspection would be performed every 6½ years for an operator flying 7 hours a day, 2,500 hours per year.[38]

Many operators contract to perform all levels of maintenance including structural inspection for Middle Eastern airlines. The structural inspections are performed mainly in Europe or the United States, but there are facilities available in the Far East and other parts of the world. Normally, the operator determines where and how much contract maintenance will be carried out.

Training Programs Associated With an Aircraft Sale.—Through training, airlines seek to become self-sufficient in aircraft operation and maintenance. Training thus directly contributes to technology absorption. Generally speaking, the smaller the airline the greater the need for follow-on training as the pool of experienced personnel and trainers is smaller.

A comprehensive and professional training program is considered extremely important to the sale of aircraft. While a superlative training program will not win the sale, lack of such a training program can significantly contribute to loss of a sale. In the competitive environment of commercial aircraft sales, this fact is well known, hence all suppliers stress training in their packages. Because of this, no one supplier has a significant advantage over competitors because of the training programs offered.

Personnel training associated with the sale of a commercial aircraft generally includes both flight operations and maintenance.[39] A typical training program offered by major aircraft manufacturers and included in the price of an airplane consists of: 1) flight operations, usually including complete training for a certain number of flight crews,[40] dispatchers, and flight attendants; and 2) maintenance training, usually including training in airframe and systems, electrical systems, avionics systems, corrosion prevention, and control, and post delivery practical maintenance training.

The three major U.S. aircraft manufacturers provide about the same level of flight operations training support. Of the three, Boeing is the most prominent in the commercial airline field, with Lockheed (maker of the L-1011) no longer producing commercial aircraft. (The McDonnell Douglas DC-10 jumbo jet is out of production except for a military version, but their MD-80 142- passenger airliner, previously called the DC-9-Super 80, is still being produced.) The amount, type, and technological sophistication of training techniques in courses offered by Airbus are roughly comparable to that offered by Boeing in both flight crew and line maintenance training.

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[37] U.S. Code of Federal Regulations, 43.17, Federal Aviation Administration, Title 14—Aeronautics and Space—Part 43, Appendix A—*Major Alterations, Major Repairs, and Preventive Maintenance*, p. 624 ff. Only two systems for overhaul are used in the world, the U.S. FAA system and a British system, with the FAA system dominating worldwide. IATA and ICAO do not promulgate overhaul specifications.

[38] For a Boeing 747 it is recommended that a major overhaul occur after 20,000 hours. However, the 747 normally flies longer flight segments. Assuming 12 hours per day utilization, or 4,400 hours per year, the inspection would be performed every 4½ years.

[39] Personnel trained for flight operations include: pilots, flight engineers, performance engineers, dispatchers, flight attendants, instructors/supervisors, and loadmasters/boom operators. Personnel trained for maintenance include: electricians, airframe and systems specialists, avionics specialists, and instructors/supervisors.

[40] "The typical cockpit crew consists of a pilot, first officer (copilot) and flight engineer. Some of the newer planes such as the Douglas MD-80 or Boeing 767 require only two people, namely the pilot and copilot. This is due to improved instrumentation and more automatic features.

Most airplane customers have a significant number of options with respect to brand names of equipment, control and functions of the avionics equipment and numbers of "systems" to be installed in their aircraft. Much of the avionics equipment is used by several different airplane manufacturers. The new integrated digital avionic systems introduced in the Boeing 757/767, McDonnell Douglas MD-80, and Airbus Industrie A310, for example, are expected "to have an impact on air carrier operations equal to the introduction of radio navaids (navigational aids) and two-way voice radio half a century ago."[41] In this case, the entire collection of avionic sensors and subsystems has been designed to function as an integrated flight control and management system. This will enhance operational efficiency and flight safety and ease flight crew work load.

Aircraft companies generally provide training in the Middle East similar to programs provided to customers in other developing or developed regions. From a flight crew viewpoint, there is not much variance among operators arising from special qualifications required to fly a specific aircraft. At the request of the customer, courses can be extended to deal with language difficulties. All Middle Eastern students must, however, meet minimum requirements before attending maintenance training courses.

According to U.S. industry experts, training of personnel in aircraft maintenance and operation in the Middle East has proceeded successfully. From a flight operations viewpoint, Middle Eastern students generally are well educated and have sufficient knowledge of English to permit efficient and effective training. (Since all flight and maintenance classes are taught in English, training time and efficiency depend on the English fluency of the students.) Language problems in aircraft operations training are usually most noticeable in the case of ground support personnel.

Egypt and Algeria have the largest numbers of nationals maintaining their aircraft, while the Saudis and the Kuwaitis the smallest. Since being a mechanic is not a prized occupation in these latter two countries, reliance on Pakistani, Egyptian, Jordanian, and Palestinian mechanics will probably continue far into the future.

Airport Development.—In the Middle East, some of the world's newest and most technologically sophisticated airports have been built to accommodate expanded airline operations. Several of the newer, larger airports in the Middle East have been planned, designed, and sometimes constructed by foreign consultants and contractors.

The selection of a site suitable for a new airport normally depends on certain criteria which are also applicable to the expansion of existing airports. The location of an airport is generally influenced by the following factors: 1) type of development of the surrounding area, 2) prevailing weather conditions, 3) accessibility to ground transport, 4) availability of land for expansion, 5) presence of other airports in the general area, 6) surrounding obstructions, 7) economy of construction, 8) availability of utilities, and 9) proximity to urban centers. These factors vary greatly among the Middle Eastern countries.

The design of the passenger terminal complex must accomodate different types of users—passengers, visitors, airlines, airport operators, and concessionaires. Different design objectives, and consequently criteria, can be identified for the different users. The most important evaluation criteria for passenger terminal planning are: 1) ability to handle expected demand, 2) compatibility with expected aircraft types, 3) flexibility for growth and response to technology changes, 4) compatibility with prevalent ground access modes, 5) compatibility with the total airport master plan, 6) potential for delay, and 7) financial and economic feasibility.

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[41] "New Avionic Systems Offer Efficiency, Safety Benefits," *Aviation Week and Space Technology*, Apr. 19, 1982, p. 52. Training programs for the use and maintenance of avionics packages at the "line maintenance" (or systems) level are modified for each customer. The "shop level" (or test/repair/overhaul level) is not considered as critical, and courses generally teach "typical configuration" components to several customers at a time.

In addition to the passenger terminal, airfreight handling and storage facilities, control tower, powerplants, fuel storage, repair hangars, administration buildings, fire station, communications, concessions, parking, often hotels or residential facilities, and public safety facilities are needed. Airport planning and development is thus a complex architectural, engineering, and logistical task.

Air Traffic Control.—Air traffic control (ATC) requires various types of navigational surveillance and communication equipment (both in the cockpit and on the ground). The technologies involved, while widely used, are fairly complex, and training in their use, maintenance, and repair is not trivial. The equipment presently installed in the Middle East ranges from state of the art to outmoded.

Aids to aerial navigation can be broadly classified into two groups: 1) those that are located on the ground (external aids), and 2) those installed in the cockpit (internal aids). Some aids are designed primarily for flying over oceans; other aids are only applicable to flight over land masses; and finally there are aids that can be used over either land or water. Some aids are used only during the en route portion of the flight, while other aids are necessary in terminal areas near airports.[42]

The principal aids for ATC are voice communications and radar. English is the international language of ATC. The controller monitors the separation between aircraft by means of radar and instructs the pilot by means of voice communication.[43]

The Operation of Commercial Aircraft Support Systems in the Middle East

Designing airports, and operating and maintaining commercial airline fleets are complex and technically demanding tasks. Some Middle Eastern countries have effectively used these technologies. A major purpose of the discussion that follows is to analyze factors contributing to this comparative success in technology absorption.

Saudi Arabia.—The Saudi Arabian national airline, Saudia, is one of the fastest growing airlines in the world. Carrying 4,000 tons of freight in 1970, it grew to accommodate 100,000 tons of cargo and 9.4 million passengers in 1981. Saudia systemwide traffic increased 11 percent in 1983 to 11.1 million passengers, and the airline expects continuing expansion in 1984, particularly on routes to the Far East. The stated goal of the International Airports Project's directorate under the Ministry of Defense and Aviation is "to plan and build airport facilities vital to the continued social progress and economic growth of the kingdom."[44]

All three international airports in Saudi Arabia are undergoing or recently completed major expansions. Jeddah's new $6 billion airport (opened in spring 1981), the King Abdul-Aziz International Airport covers 104 square kilometers, making it in area the biggest in the world. Bechtel (U.S.) supervised construction while a Ralph M. Parsons/Daniel joint venture

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[42] Robert Horonjeff, *Planning and Design of Airports* (New York: McGraw-Hill, Inc., 1975). For further descriptions of alternative ATC systems, consult *Airport and Air Traffic Control Systems*, OTA-STI-175 January 1982, and *Review of the FAA 1982 National Airspace System Plan*, OTA-STI-176, August 1982, both publications of the U.S. Congress, Office of Technology Assessment, Washington, D.C.

[43] There are two types of radar: primary and beacon. Primary radar shows reflections from the aircraft body as small "blips" on a radarscope. Beacon radar (sometimes referred to as secondary radar) consists of a radar receiver and transmitter on the ground that transmits a strong coded signal to an aircraft if that aircraft has a transponder. A transponder is an airborne receiver and transmitter which receives the radar signal from the ground and responds by returning a coded reply to the interrogator on the ground. Most commercial aircraft carry transponders.

[44] "Saudia Continues Growth—At a Cost," *Middle East Economic Digest*, Aug. 28, 1981, p. 29; Roy Allen, "Air Freight Business Zooms Ahead," *Aviation: A Middle East Economic Digest Business Feature*, June 25, 1982, pp. 62-64; "Saudia Expects Traffic Rise to Continue," *Aviation Week and Space Technology*, May 28, 1984, p. 37ff.

Photo credit: Saudi Arabian Presidency of Civil Aviation

New Riyadh Gateway—King Khaled International Airport is the new aerial gateway to Riyadh, capital city of the Kingdom of Saudi Arabia. Its four-passenger terminals are all served by air bridges. The mosque, center left, rises 40 meters above the arrivals level roadway

operates it. The new Riyadh airport, which will exceed Jeddah's in eventual size, was also built by Bechtel, using more than 12,000 workers from 35 countries.[45] The third major airport is Dhahran International.

Saudia has had a predominantly U.S.-manufactured fleet until its latest purchase of 11 wide-bodied Airbuses for delivery in 1984. In order to service its large fleet, Saudia has established extensive maintenance facilities. Saudia completed a comprehensive maintenance facility in 1979 and can perform all of its own aircraft checks and overhauls. TWA has had a deep influence on Saudia standards and operating procedures, but European influences have also been felt.

Recruitment of personnel, both ground and flight crews, has been international in scope. Saudia now has over 600 pilots. Saudia expects 400 to be nationals by the year 1990. Until recently, training of Saudia pilots has occurred largely in TWA facilities in the United States. The suppliers of hardware (and software) for the computerized reservation system have also been involved in training of Saudia staff. Much of the training of staff, except for pilots, has taken place in the extensive Saudia facilities in Jeddah.

Training of Saudi nationals by both Saudia airlines and for the Presidency of Civil Aviation has been more successful, according to experts, than technical training in most other sectors of the Saudi economy. Faced with extremely high costs for expatriate labor, Saudia chose to recruit high school graduates and gave them in-house training. Most Saudia traffic agents are now Saudis and most middle and lower management personnel are also Saudis.

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[45] "Transport: Airport Facilities Keep Pace With Kingdom's Growth," *Saudi Arabia: Middle East Special Report*, John Whelan (ed.), Middle East Economic Digest House, London (August 1982), pp. 161-164. See also, Robert Bailey, "Countdown Begins for Jeddah Airport," *Middle East Economic Digest*, Apr. 17, 1981, p. 42.

Photo credit: Trans World Airlines

Saudia's Boeing 737 Simulator

Photo credit: Trans World Airlines

Saudia flight training students in Saudia simulator

More than half of the flight crews are now Saudi nationals.

In certain technical areas and in the more complex maintenance of aircraft, Saudia still depends on foreign technicians. A drive to find, train, and retain Saudis in this field is now under way, but it will be several years before the majority of such technicians are Saudi nationals.

Saudia now performs all A, B, C, and D checks, and plans to carry out base checks (every 6,000 hours) on its Lockheed TriStars. Saudia can carry out major repairs and hot section maintenance on several types of engines. By 1984, Saudia plans to contruct and operate an entirely new maintenance base in Jeddah, which will meet projected maintenance requirements to the year 2015. Saudia has recently begun operations with a twin-cell civil engine test facility located in a new support area of Jeddah's King Abdul Aziz International Airport.

In a given year, more than 700 hangar visits will be made by Saudia aircraft for routine checks, modifications, and repairs. Saudia uses its own Automatic Test Equipment, a computer-controlled laboratory facility, to diagnose problems in electronic equipment so that airplanes can be put back into service with the least possible delay. The Saudia Metrology Laboratory tests and calibrates the equipment used in the aircraft to ensure proper performance. Their MEMIS (Maintenance and Engineering Management Information System) is particularly useful in time control, and in the issuance of purchasing and repair orders. Self-sufficiency in maintenance is thus rapidly being realized within Saudia, and maintenance training courses are being expanded to include more and more key personnel.

The Bendix Corp. (U.S.) is engaged in a 15-year agreement which aims to eventually staff Saudi Arabia's airports with Saudi nationals.[46] In a separate award, Bendix's technical services subsidiary, the Bendix Field Engineering Corp., won a $337 million, 5-year air traffic control contract. It will supervise 31 airports in operations, systems engineering, and maintenance. Six hundred Saudi staff will be needed; 500 of them will be managers and technicians.[47]

Saudia thus eventually expects to operate without a major expatriate work force. On the other hand, one reason why the airline has operated at a loss over the past few years is its massive investments in training, computerized systems, and flight simulators, as well as new aircraft and other capital investments.[48] In 1980 alone, official subsidies for Saudia Airlines amounted to almost $75 million. The airline is determined to eliminate subsidies gradually through higher fares and increased efficiency. The government, through accounting and financing procedures, is attempting to provide incentives to operate the airline as a profit-seeking enterprise. Saudia's airfreight business has been an important component of its growth and Saudia is considering modifying its A-300s on order to a combination passenger-freight configuration. Aiming to make the new airport at Jeddah the hub for airfreight traffic to the Middle East, the airline plans to increase its airfreight business and enhance profitability.

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[46] "Turning Point for U.S. Commission," *Middle East Economic Digest*, Special Report on Saudi Arabia, July 1981, p. 18. See also "Saudis Seek Technical Self-Sufficiency," *Aviation Week and Space Technology*, May 14, 1984, pp. 68-70.

[47] "U.S. Company Wins Air Traffic Contract," *Middle East Economic Digest*, Aug. 15, 1980, pp. 29-30.

Saudia, which tries to restrict recruitment to nationals, expanded its training budget in the late 1970's: the budget grew by 164 percent between 1977 and 1981 to $47.7 million. In 1977, there were 4,261 trainees; the figure projected for 1981 was 9,149.[49] Approximately 1,200 Saudi nationals are being trained by Saudia at its $42 million institute in Jeddah. Some Saudi nationals are also studying in the United States.[50] Saudia courses include flight crew training, computer programing, marketing, and technical and managerial skills. World Wide Languages (United Kingdom) computerizes translations and typesets manuals dealing with installation, operations, and technical specialties. Indicating the international nature of Saudia operations, the manuals are reproduced in Arabic, Russian, French, Spanish, Chinese, and English.[51]

The key to the long-term objective of "Saudization," says Ibrahim Serage, Saudia's training director, is giving trainees sufficient incentives and "opportunities for promotion. This means we are not training people simply for jobs, but for career development."[52] In 1980, the company recruited 700 employees, of which 200 became Saudi flight crew.[53] The ratio of Saudi pilots to nonnational pilots fell from 1975 (75:25) to 1980 (50:50) as the demand for flyers grew rapidly. The goal is to raise the ratio to the 1975 level by 1985. To that end about 100 pilot trainees are recruited each year. Some observers have pointed to the tragic fire on the Lockheed TriStar L-1011 on August 19, 1980, as an indication that Saudia may be growing too fast.[54] Nevertheless, Saudia has a good maintenance record and its pilots are generally considered capable.

The strides being made by Saudia are very impressive; complete staffing by Saudi nationals, however, will not occur in the near future. Successful technology absorption in several aspects of commercial aircraft support systems has come as a result of lengthy experience, and a strong commitment to training. Saudia is a comparatively independent operation and can offer technicians exceptional housing and other perquisites and has, therefore, been able to recruit and retain educated blue-collar technicians. Training programs have been costly, but they have contributed significantly to the high quality of operations and maintenance of Saudia.

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[48] Roy Allen, "Air Freight Business Zooms Ahead," op. cit., pp. 62-64.

[49] Edmund O'Sullivan, "Saudi Arabia—Bridging the Labour Gap," *Middle East Economic Digest*, May 22, 1981, p. 53.

[50] The Sierra Academy of Aeronautics located at Oakland International Airport, Oakland, Calif., will use a computerized, multi-engine aircraft simulator to train pilots from Saudi Arabia. The training features the 99 instrument approaches used at King Abdul Aziz International Airport, Jeddah International Airport, King Khalid International Airport, Riyadh International Airport, Dhahran International Airport, and airports in 15 other cities in the Kingdom, "Courses for Saudi Pilots Added to U.S. Program," *Saudi Report*, Jan. 24, 1983, p. 3.

[51] "Saudi Arabia Continues Growth," op. cit., p. 30.

[52] Quotation cited in "Saudi Arabia—The Manpower Controversy," *Middle East Economic Digest*, Apr. 24, 1981, pp. 40-41. See also "Saudis Seek Technical Self-Sufficiency," *Aviation Week and Space Technology*, May 14, 1984, pp. 68-70.

[53] "Saudi Arabia Continues Growth," op. cit., p. 29.

[54] John Whelan, "Airline Safety Questions Follow Riyadh Disaster," *Middle East Economic Digest*, Aug. 29, 1980, p. 35. The official declaration of cause for the accident which killed 14 crew and 287 passengers was a fire of undetermined origin in the cargo compartment. Factors contributing to the fatal results were listed primarily as pilot error in not making a maximum stop landing and immediately evacuating upon landing and not properly utilizing the flight crew during the emergency. Information provided by the National Traffic Safety Board, Washington, D.C., March 1984.

Kuwait.—Kuwait's aim to become a regional center and a hub in East-West air traffic has been the driving force in civil aviation policy and the growth of Kuwait Airways during the past two decades. Kuwait Airways is unusual among world-class airlines in that it has no domestic air service. Yet Kuwaitis probably travel more by air than people from almost any other nation. The airline, however, cannot make up in receipts on international air travel for the lack of domestic air service. In addition, heavy losses due to increased operating costs in the past 3 years, and the fact that longer range aircraft make stops in the Middle East less necessary than before, have changed the likely future growth pattern of the airline and probably will modify the need for building a new airport.

The Kuwait Airways Corp. (KAC) has been expanding the range of services it offers using eight-seat aircraft that fly up to 6 hours nonstop. Air taxis to the Persian Gulf and parts of Europe were initiated in 1982. The goals of the new service are said to be to reduce the use of private planes and to increase sagging revenues of the company. Another tactic to boost profits is the goal of increasing KAC's market share on Gulf flights. To do so, however, fares were reduced by 35 percent for trips within the area in order to make the airline more competitive.

Kuwait Airways has placed a ceiling on further hiring, and the management intends to cut the substantial losses of the past few years through emphasizing profitable routes, such as the one to New York, and perhaps by offering less frequent service or canceling some routes. Politically, however, it may be difficult for Kuwait to withdraw from certain routes while continuing to serve others.

Kuwait's sole airport, Kuwait International, was built in the 1970's. In the 1970's the British firm Frederick Snow designed a runway which an Italian contractor was unable to build in the very hot climate of Kuwait. A Japanese architect, world-famous in this field, solved the problem: huge slabs had to be sawed in two at great expense. This remains a well-remembered example to Kuwaiti planners of the need to monitor technology transfers.[55]

An airport development plan completed in 1975 has been largely ignored, and the present Civil Aviation Department has authorized a new conceptual study by Aeroport de Paris to cover requirements to the year 2000. An IATA team has prepared another report on the subject. Both reports identify coordination between military and civilian airport needs as a major factor in determining whether or not a new second airport can or should be built. Another key issue is Kuwait's future importance in regional and international air traffic. Studies indicate that the existing airport, with a design capacity of 4 million passengers per year, will have to cope with about 5 million passengers by 1990. This compares with 2.8 million in 1981. Like Algeria and Egypt, Kuwait is thus anticipating a growth in air passenger traffic beyond its present physical and service capacities.

The aircraft support industry in Kuwait is heavily staffed with nonKuwaitis. Even prior to the completion of expansion plans, efforts were made to expand recruitment. For example, in August 1980 airline pilots (as well as employees of the fire department) were exempted from military conscription. The overburdened airport traffic controllers were to be "stretched" by upgrading automated controls. A computerized radar system was put into effect in September 1980 at a cost of $3.7 million. Chief executive officer of KAC Ahmad al-Mashari announced in June 1981 that an inservice training system for Kuwaiti and other Arab engineers and technicians had been started.[56]

Staff training is included in the $775 million contract between KAC and Airbus Industrie for purchase of 11 aircraft.[57] Some say that the Boeing 767 had the technical edge over the Airbus A310; moreover the U.S. company had the advantage of having provided the rest of KAC's fleet. Boeing reportedly lost this award for political reasons. The Airbus was reportedly selected because the political positions of major consortium participants, particularly France, were seen as more acceptable.[58] Political considerations in aircraft sales in the region are covered in more detail in a following section.

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[55] Pacific Consultants, the Ballast Nedem (the Netherlands), and Soleco (Italy) were all involved in the building of the airport. Minor parts of the present airport system, including the jetways, were designed or furnished by U.S. firms. The airport development plan was drawn up by the Netherlands Airport Consultants.

[56] "KAC Plans Major Projects," *Middle East Economic Digest*, June 12, 1981, p. 28.

The political importance attached to having a national airline should not be overlooked in explaining Kuwait's strategy. In the future, KAC's expected increase in services and assets will result in expanded requirements for skilled manpower, even with more extensive use of automation. Two points should be noted. First, there is no indication that the work force will be primarily Kuwaiti. Dependence on expatriates must be increased to carry out these plans. Secondly, although training is included in the plans, it is not clear whether the planned training is sufficient in view of the physical expansion.

Egypt.—Expansion of Egypt's civil aviation sector has been uneven during the past few years, despite projections which show large future increases in passengers. While financing problems have not postponed construction of airport facilities and telecommunications improvements, EgyptAir has had to retrench plans for major aircraft purchases.[59] Redefinition of its market segment, competition, and management problems have contributed to the slowdown in expansion of the state-owned air carrier.

Passenger traffic through Cairo is expected to rise rapidly from the current level of 4 million passengers per year, possibly at a rate of 15 percent annually.[60] The airport at Cairo will be expanded according to designs by Aeroport de Paris. The first annex will raise overall capacity from 5 million to 10 million passengers annually when it is completed in 1984. Another 5 million may be accommodated by a second annex to be built by 1987. The airport plan allows for completion of further annexes as necessary.

A complete overhaul of the air traffic control system for the whole country is underway Thompson-CSF (France) will build and equip the Cairo air navigation center as well as seven radar stations in other parts of the country, linked together by microwave. Air traffic controllers will be trained on the SIMCAT simulator to be supplied by Thompson-CSF. The French Government is helping the Egyptian Government to finance the package—worth $72.5 million. The French officially subsidized financing was reportedly a critical factor in the decision to choose the French company.

Regional airports at Alexandria, Aswan, and Luxor are being improved. There has also been discussion of building two new international airports in the northern Delta area. These would be located at Alamein and Ameriyah and would tie into industrial development schemes for the region.[61]

EgyptAir has been redefining its relationship with the government over the past few years. Ali Gamal al-Nazer, Tourism and Aviation Minister, announced in November 1980 that the company was doubling its capital to $72 million through investments from the National Bank of Egypt and the Misr Insurance Co. Independent observers noted that EgyptAir had been permitted to exercise increasing autonomy and had been commercially successful, recording operating profits of $17.4 million for 1979.[62]

Nonetheless, planned investments have been scaled back. Orders for four McDonnell

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[57] *Middle East Economic Digest, vol. 25, May 29, 1981, p 26.*

[58] *"Pro-Arab Stand 'Wins Airbus Deal'," Middle East Economic Digest,* July 11, 1980, p. 34. The number of aircraft given in the 1980 announcement of the contract award was six but the 1981 figure was revised to 11.

[59] Alan Mackie, "EgyptAir Trims Expansion Plans," *Middle East Economic Digest,* Sept. 5, 1980, pp. 3-4.

[60] Robert Bailey, "Safety First at Cairo Airport," *Middle East Economic Digest,* June 12, 1981, p. 24.

[61] "Northwest Development Planned," *Middle East Economic Digest,* July 3, 1981, pp. 7-8.

[62] Mackie, op. cit.

Douglas (U.S.) DC-10/30 aircraft were canceled in August 1980. Referring to the purchase of three Airbus Industrie A300s, the Tourism and Aviation Minister said that the new investments could not all be made simultaneously.[63] The company decided to forgo the long-haul market, for which the DC-10s were ordered, concentrating exclusively on the medium-range market. Further planned investments were being limited. Discussions focused on either canceling or reducing in size by 75 percent the planned maintenance center to service the Airbuses at Cairo Airport.

The government, nonetheless, affirmed its support for EgyptAir's virtual monopoly as it protected the company from potential competition from a newcomer. Arabia (Arab International Airlines) was incorporated in December 1978 with $15 million in capital owned 60 percent by private Egyptian and 40 percent by Saudi Arabian investors. Its staff of 150 were all Egyptians.[64] But after operating for less than 6 months, it was forced to terminate operations. It was not permitted to fly on lucrative international routes, which would bring it into direct competition with the state-owned company. Closely restricted domestically, Arabia finally succumbed to price-cutting tactics. Further evidence of the government's commitment is the fact that of the $226 million allocated for civil aviation in fiscal year 1981-82, EgyptAir was to receive $103 million.

The Egyptian labor profile, which includes an abundance of labor and a large professional contingent, is well suited to air transport. Specific vocational training programs are required, however, for each occupational category (the four major areas being aircraft pilots, flight attendants, ticket and station agents, and aircraft mechanics). Skilled labor occupations such as mechanics may present the greatest difficulties in terms of availability of labor, while training flight attendants and ticket agents does not present a great problem.[65]

Algeria.—Algeria is simultaneously expanding airports, purchasing aircraft, and planning for increased demand for trained staff due to the forecasted increases of 3 million to 5 million passengers annually in passenger air traffic during the 1980/84 development plan period.[66] Two of the fundamental criteria involved in the plan are to decrease charter freight and to upgrade the fleet in the face of growing air traffic.

The Algerian 5-Year Plan mentions allocations for a potential fleet of 54 aircraft. However, because aggregate investment levels are not specified, it is unclear how much expansion beyond present levels will actually occur. The 1980-84 development plan aims to provide international coverage for the southern part of the country and to expand facilities in the north to meet increasing demand. Approximately 30 airports are to be built or upgraded, 20 of which are located in the south. These will be used primarily for short-haul stopovers en route to points in west, central, and southern Africa.

Contracts for design and construction of two of these airports were recently won by the state-owned International Airport Authority of India. The turnkey contracts for the airports at Batna and Setif are reportedly valued at $100 million.[67]

Despite deliveries in May 1982 of two Boeing aircraft, a 737 and a 727, Airbus Industrie appears to be gaining ground in negotiations. One attractive feature of Airbus proposals has been broad sales and leasing packages that take manpower needs into consideration. For example, Lufthansa (West Germany) will train Air Algérie crews on A300s at the Frankfort/Sieheim base of Lufthansa.[68] This arrangement is part of the terms of a lease for two Airbus Industrie medium-range passenger planes. Eight Air Algérie maintenance teams will also receive technical training. Until the Algerians are fully able to take over operations, Lufthansa itself will provide crew and maintenance technicians.

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[63] "Egypt Cancels DC-10s," *Middle East Economic Digest*, Aug. 29, 1980, p. 18; Mackie, op. cit.

[64] Jenab Tutnji, "Arab Wings: Flying the Charter Way," *Middle East Economic Digest*, June 26, 1981, p. 26.

[65] Egypt's acquisition of military aircraft technology (through licensed assembly and military procurement) may improve technical capabilities useful to the commercial aircraft sector. See Clarence A. Robinson, Jr., "Egypt Seeks Technology Transfer," *Aviation Week and Space Technology*, Aug. 15, 1983, p. 129ff.

[66] Michael Frost, "Algeria Plans Major Airport Expansion," *Middle East Economic Digest*, Aug. 28, 1981, p. 7.

[67] *Middle East Economic Digest*, July 2, 1981, p. 4; "Indians Sign Airport Contracts," *Middle East Economic Digest*, Nov. 5, 1982, p. 13.

According to some estimates, Algeria may need up to 25 Airbus Industrie A300s in the next 15 years.[69] Although the comparable Boeing 757 is less expensive, Airbus is said to have the edge. In this case the French have offered to train Algerian engineers and aircraft mechanics at Airbus' factories in Toulouse. Moreover, the French proposed to set up complete maintenance facilities for Air Algérie at El-Djazair within 3 years.

A civil aviation school for pilots and technicians is planned as a step towards implementation of the current development plan.[70] The school, to be located in Constantine, will be modeled on the Ecole Nationale d'Aviation Civile in Toulouse.[71] Its estimated value as a turnkey package is from $115 million to $230 million. Funding of $818,800 has been provided through the United Nations Development Program while the Algerian Government has allocated some $68.2 million. The Enterprise Nationale d'Exploitation Meteorologique et Aeronautique, within the Transport Ministry, is in charge of the project. Tractionel (of Belgium) is carrying out preliminary studies for the proposed 636-student institute.

Algeria plans to purchase sophisticated equipment for use in training and research. For example, Algerian leaders have been discussing the purchase of flight simulation equipment from Latecoere (France). The simulators would be used for testing the physiological effects of flying on the flight crews as well as for testing aeronautical equipment.[72] Algeria has plans to purchase a research aircraft with the help of a $7 million loan from the Arab Fund for Economic and Social Development (AFESD). It will be used for testing ground control equipment by some African and all Arab countries.[73]

If Algeria proceeds with its planned fleet expansion, investment on the order of $55 million could be required and an additional 1,000 workers could be needed. It appears that the overall composition of the national labor force could support the annual levels of growth planned in airline-related occupations, given adequate vocational training in the specific occupations required.

Serious attempts are thus being made by Algeria to develop manpower apace with increases in air traffic and airport expansion. Airbus Industrie, with its multigovernment support, is said to offer attractive training arrangements and financing terms. Thus Airbus is said to be favored for large purchases of aircraft in the coming years.

Iraq.—Iraqi Airways uses Lufthansa service for its aircraft maintenance but performs its own routine maintenance (A and B checks). Plans have been laid to build new airports in most provinces with a view to expanding and improving Iraqi Airways services. There are plans to expand the domestic network through airports to be built at Arbil, for which the design contract has already been let, and at Amara, Kirkuk, and Najaf.[74] Decreased oil revenues and the strains of the Iran-Iraq War, however, make delay of these plans likely.

Iraqi Airways has experienced impressive growth, especially since 1977, and considerable investments have been for new airports, both international and domestic. Foreign contractors from a wide variety of nations have participated. Pacific Consultants of Japan won contracts for airport design studies in 1976 and 1978. The major construction contract for the Baghdad International Airport (valued at $900 million) was awarded in 1979 to the French company Spie-Batignolles and Fougerolle. The major Basra Airport construction contract was awarded in 1980 to an Austria-West Germany consortium of Universale Hoch and Treflou and Bil Pinger. In 1978 Scott, Brownringy and Turner of the United Kingdom received a contract of unspecified amount for design of passenger terminals; another British group, Kirkpatrick and Partners, received an airport consultancy contract in 1982. In conjunction with the contract, Pakistan's Feedai Agency is supplying labor for this construction.

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[68] "Air Algérie Leases Airbuses," *Middle East Economic Digest*, May 22, 1981, p. 8.

[69] "Airbus Looks to Air Algérie," *Middle East Economic Digest*, Oct. 15, 1982, p. 6. It presently has no Airbus or Boeing aircraft on order, however.

[70] Frost, op. cit.

[71] *Middle East Economic Digest*, Feb. 27, 1981, p. 8.

[72] "Aviation Contract Discussed," *Middle East Economic Digest*, Apr. 11, 1980, p. 22. The contract was valued at $45 million.

[73] *Middle East Economic Digest*, Aug. 8, 1980, pp. 15-16.

[74] Information provided by U.S. Department of Commerce, International Trade Administration, Feb. 10, 1983.

The primary suppliers of passenger aircraft and parts have been U.S. corporations. Three Boeing 727s and 747s, at a cost of $183.6 million, were sold in 1981. Three other 727s were sold in 1980. In 1975, two 747s, three 727s and one 737 were supplied by Boeing at a cost of $150 million.

The State Organization for Civil Aviation has plans to build a comprehensive training institute. Programs in operation and maintenance of airports, aircraft, air traffic control, and radar equipment will be offered. Pilots and cabin crew will be trained in a broad range of skills, including foreign languages.[75]

Iraq has been active in developing specialized manpower for its commercial aviation sector. Now that women as well as men are being admitted to train as pilots at the Takrit air force academy, the pool of skilled labor that could be eventually drawn from military to civil aviation may be expanded once the Gulf war is ended.[76] This move is indicative of national policy to expand the indigenous labor force.

The government is not waiting for domestic facilities to be completed before intensifying training activities. In October 1981, British Airports International won a $1.3 million contract to train over 400 Iraqis in airport electronics.[77] The courses to be given in the United Kingdom will include both classroom study, at universities and technical institutes, and hands-on training at airports and at centers of aviation equipment manufacture. A similar contract worth $530,000 to train Iraqi air traffic controllers in the United Kingdom was awarded at the same time.

British firms thus have been particularly successful in the Iraqi aviation training market. Some companies have had long-time working relationships with Iraq, such as the Lancer Boss Group which has been dealing with Iraqis for 20 years. Non-British firms have made inroads in this market. For example, in January 1982 an airport staff training contract worth $1.4 million was awarded to the West German firm Flughaven Frankfort am Main.

The national airline of Iraq continues to operate despite the war with Iran. Under present circumstances, however, it is unlikely that Iraq would divert capital investment or occupational training (pilots and aircraft mechanics) from the military in order to build up the commercial airline industry.

Iran.—Iran Airways presently handles most of its own routine maintenance, with the assistance of technical specialists from other countries. Major overhauls are carried out abroad. Iran's Fifth Development Plan, (1973-77), under the Shah's regime, called for expansion of existing airports and the construction of new airports, including the new Teheran airport scheduled for completion in 1980. Authoritative information on the current status of these projects and of Iran Air is unavailable, although it can be assumed that military capabilities have been given priority over commercial aviation in the air transport sector.

As of 1982, Iran Air was reported to have a labor force of 5,500 trained technical personnel. Iran carried on negotiations with Australia to set up a training program for Iran Air.

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[75] *Middle East Economic Digest*, Apr. 10, 1982, p. 28.

[76] *Middle East Economic Digest*, Apr. 9, 1982, p. 5.

[77] *Middle East Economic Digest*, Oct. 16, 1981, p. 28.

About 150 commercial pilots of the national airline would be involved in the program.

Iran reportedly has budgeted some $33 million over the next 5 years for building a new international airport south of Teheran. Design and preliminary construction were completed prior to the Shah's overthrow. Plans have been scaled down from an annual capacity of 20 million passengers to 7½ million. Total cost is now estimated at between $100 million to $200 million. Despite the political situation, Iran's commitment to the airport project suggests that the government expects more international visitors and is willing to provide modern facilities for them.[78]

Regional Efforts.—The expansion of air traffic in the Middle East over the last few years has seen considerable cooperation among regional and national carriers. One official, speaking about joint provision of air services between the Middle East and North America, summed up the general situation quite succinctly: "At the moment we do not have the equipment, the machinery, or the manpower to do it [cover demand for services] individually. The idea is for a pooling of resources to benefit everybody."[79]

In 1980 a technical consortium was formed that included Middle East Airlines, Saudia, Kuwait Airways, Gulf Air, and ALIA (the Royal Jordanian airline). The consortium also held discussions with other members of the Arab Air Carriers Organization (AACO), but none have yet joined. Programs being considered or actually underway include shared services (especially telecommunications) and unified training.

Shared Services.—Sharing electronic equipment and technical services may be an attractive option for Middle East carriers. Highly specialized electronic and telecommunications may cost as much as 20 percent of the total sum required for a new airport. Elements typically included in a turnkey package are radar, telecommunications, navigational aids, and lighting. Multinational corporations or consortia of suppliers of equipment and services generally offer to install, maintain, and staff the airport.

In order to limit the number of expatriate workers who form the largest proportion of the technical staff in most cases, airlines in the Middle East have the option of automating operations. Keeping the labor component to a minimum while at the same time developing regional capabilities requires coordination in telecommunications services. Perhaps the most impressive effort is the joint computerized reservation system.[80] Based in Bahrain, it will handle an estimated 10 million reservations a year for the 10 airlines involved: ALIA, Domestic Yemen Airlines Co. (South Yemen), Gulf Air, Kuwait Airways, Libyan Arab Airlines, Middle East Airlines, Saudia, Sudan Airways Corp., Syrian Arab Airlines, and Yemen Airways (North Yemen). At present only Gulf Air has its own computer reservation facilities; the rest lease services from outside the region. Iraqi Airways did join the group because it has a central computer judged to be adequate.

Another labor-intensive service that could be performed more cheaply through a regional center is the calibration of instruments. Among the Arab countries, only Saudi Arabia has such capabilities. A regional air traffic control system may be attractive from an economic perspective, but there is overlap between the military and civilian control networks so that such cooperation may not be politically feasible. Aircraft maintenance centers and joint catering services are under discussion.

Unified Training.—Royal Air Maroc's experience with training Moroccan nationals for technical flight staff shows how expensive training can be.[81] In 1980, the airline announced its goal of complete staffing with Moroccan nationals by 1982. The 1980 deficit of $2.6 million (up from $1.9 million the year before) was attributed largely to training costs totaling $3.8 million in 1980. As of June 1980 approximately 60 percent of the technical staff was Moroccan. Nevertheless, the airline has expanded its role in regional training. The Arab Civil Aviation Council has considered promoting Morocco as a base for a civil aviation high technology institute.[82] The Royal Air Maroc center in Casablanca is training some African airlines students (e.g., from Air Mali, Air Zaire, and Air Mauritania) in addition to Moroccan nationals.

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[78] *Middle East Business Intelligence*, vol. 2, No. 13, Aug. 15, 1983.

[79] "Arab Airlines Plan Atlantic Route," *Middle East Economic Digest*, June 20, 1980, p. 16.

[80] Robert Bailey, "Airlines Plan Computer Reservation Centre," *Middle East Economic Digest*, Apr. 11, 1980, p. 19. The project is estimated to cost $30 million to $40 million.

[81] David Hawley, "Royal Air Maroc . . . Facing the Competition," *Aviation: A Middle East Economic Digest Business Feature*, vol. 26, June 26, 1982, pp. 62-63.

The AACO has met with some success in joint training of management-level staff. The Douglas Aircraft Co. (subsidiary of McDonnell Douglas Corp., U.S.) organized a popular seminar for the 18-member AACO in August 1981. This was followed the next year by a marketing course offered to 25 executives from the group. Sessions included fleet planning, aircraft financing, performance assessment, and forecasting.[83]

In September 1981 the chairmen of several Arab airlines met to consider a unified training system as well as the joint building of a large airport hangar. The airlines involved were Kuwait Airways Corp., Saudia, Middle East Airlines, Gulf Air, and ALIA. There has, however, been no reported progress in these ventures.

There is general agreement that cooperation among Arab airlines is economically desirable and perhaps necessary to reduce staff requirements of individual carriers. The AACO is the most comprehensive organization, but various smaller groups of countries have participated in joint programs. The notable achievement has been the development of the Bahrain-based, centrally computerized reservation system. Joint provision of other telecommunications, maintenance, and training services has been discussed rather more than implemented.

PERSPECTIVES OF SUPPLIER COUNTRIES AND FIRMS

Commercial aircraft support systems comprise a variety of equipment and services needed to operate and maintain local airlines in the Middle East. As discussed earlier, they fall into two groups: the goods and services needed to operate aircraft, and those needed to operate airports. The former are usually supplied by other airlines, aircraft and aircraft engine manufacturers, and aircraft maintenance firms. The latter are supplied by a diverse group of communications, aerospace electronics, and airport construction firms.

The diversity of products exported to be parts of airports and air navigation traffic control systems, and the large services component in aircraft maintenance and operation preclude any simple analysis of trade flows. While most equipment for aircraft and aircraft engine maintenance is exported as aircraft parts (SITC 7349), a large portion is linked to the original aircraft purchase.[84]

A multitude of equipment manufacturers often coordinated by construction management firms, provide the various airport systems components. For example, Bechtel was has the construction manager for the new Riyadh airport, but the equipment installation and construction was handled under a number of separate contracts. The French firm

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[82] Bailey, "Airlines Plan Computer Reservation Centre," op. cit., p. 19.

[83] "Arab Airline Chiefs Discuss Cooperation," *Middle East Economic Digest*, Sept. 11, 1981, p. 4.

[84] The major equipment items in this sector are listed according to Standard Industrial Classification (SIC) and Standard Industrial Trade Classification (SITC) code numbers:

Commercial Aircraft Support Systems Equipment Classifications

SIC code		*SITC*	*SITC (revised)*
3662	Air Traffic Control Systems	724, 7248	764,7648
	Aircraft Control Systems		
	Electronic Flight Simulators		
	Instrument Landing Systems (Airborne and Ground)		
	Inertial Guidance Systems		
	Electronic Navigation Equipment		
	Radio Equipment		
	Radio Antennae		
	Radio Telephone Equipment		
3721	Aircraft	7341	792
3724	Aircraft Engines and Parts	7114	7131
3718	Aircraft Parts and Auxiliary Equipment	7349	7928, 7929
	Instrument Panel Mockups Training Aids (except electronic)		
1611	Airport Construction		-

Thomson-CSF is supplying air traffic control and navigation systems. Firms from the United Kingdom are also active, particularly in Saudi Arabia. Germany's major presence has been in Iraq, while U.S. firms are primarily involved in Saudi Arabia. Some recent commercial aircraft support system contracts awarded in several Middle East countries are shown in appendix 7A in tables 7A-1 to 7A-5.

Aircraft maintenance and support are performed by the local airline, by foreign personnel employed by the local airline, or by foreign airlines and maintenance firms on a contract basis. The contracts in the Middle East (and elsewhere) cover a 3- to 5-year period. This is done to spread the nonrecurring costs over a broader base, thus lowering the person-month rate.[85] As mentioned previously, after the initial aircraft sale, there is a substantial amount of follow-on training for flight operations personnel, especially for smaller airlines which do not have their own training program. Crews and performance engineers are trained and previously trained personnel are brought up to instructor qualified level. There may be a significant amount of follow-on maintenance training in the more specialized areas, such as rigging and composite repair.

The degree and magnitude of the follow-on spare parts business is determined by many variables, including:

1. The amount of spare parts initially purchased from the manufacturers and suppliers prior to delivery of the first aircraft.
2. The degree of customer expertise in airplane maintenance and repair of parts removed from aircraft.
3. The number of airplanes of a particular make the customer has in operation. For example, the same quantity of certain high-cost repairable spare parts is sufficient to support one or several aircraft. As a general rule, however, the larger the fleet, the more spares that are needed over time.
4. Daily utilization by the customer of the fleet and the route structure. The higher the utilization rate of the aircraft, the more spares are needed in inventory at the main base and at those locations included in the route.
5. The extent to which a customer participates in pooling of inventory with operators in the same region.

Fleet homogeneity assists in maintenance since the publications, training, ground support equipment, and spare parts needed reflect only the differences between early aircraft and later model aircraft of the same model. Maintenance capabilities can be pooled, but usually these capabilities and services are contracted. There are, however, several consortiums whose members perform maintenance for each other. These usually do overhaul work for the consortium. For example, one operator may do engine and auxiliary power unit work; another hydraulics; another airplane structures. Regional airline spare parts pooling agreements are administered and controlled by the airlines—prime manufacturers are not participants. Most Middle East customers currently participate in the International Air Transport Pool (IATP).

Competition Among Suppliers in Technical Assistance and Commercial Aircraft Sales

The factors which affect competition among firms supplying technical assistance to airlines in the Middle East are, not necessarily in order of importance, fleet compatibility, geographical proximity/route compatibility, historical ties, and commitment to service. Fleet compatibility, or capacity for type-specific maintenance and support, and geographical proximity are more prerequisites than competitive factors. Historical ties have been an important determinant of technical support relationships, but they must be reinforced in order to remain influential. Underlying historical ties with foreign airlines are bilateral political relations. With the exception of MEA and Trans-Mediterranean (all cargo), Middle Eastern airlines are government owned, heightening the importance of political factors. While the contracting of maintenance services is not necessarily a long-term commitment, combined with other technical services and assistance it is an important aspect of airline operations and is unlikely to be entrusted to an airline of a country with poor or faltering political relationships. Price, which is always a factor, is sometimes not as important a consideration as quality and efficiency of service combined with commitment. It is costly and disruptive to have aircraft grounded; airlines have been willing to pay for reliability in service.

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[85] Person-month rate is the cost of employing a person for 1 month including salary, benefits, and general overhead.

Sales of large commercial aircraft lead to sales of auxiliary equipment and services. Table 66 shows the large U.S. export value of sales of large commercial aircraft. In 1982, sales to the Middle Eastern region were surpassed only by sales in the European and Asian regions.

The Boeing Commercial Airplane Co. hopes to sell aircraft valued at $600 million to $800 million to Middle Eastern customers in 1984 alone. According to projections from Boeing, the world market for commercial jet aircraft between 1983-95 will be worth about $185.1 billion at constant 1984 prices. Of this, 3 and 4 percent will come from the Middle East and Africa, respectively, representing total sales of $12.9 billion.[86] Middle Eastern sales may be an important indicator for sales in the rest of the world. Whether carriers in the Middle East will invest in brand new aircraft, or refurbish or buy used planes in order to meet their expected growth, is a major question for supplier firms.

The chief rival of Boeing and McDonnell Douglas is Airbus Industrie, a multinational group of companies that are wholly or partly owned by European governments. Members of Airbus Industrie are Aerospatiale of France (37.9 percent ownership), Deutsche Airbus of Germany (37.9 percent), British Aerospace (20 percent), and Construcciones Aeronauticas of Spain (CASA) (4.2 percent).[87] Airbus Industrie was formally constituted in December 1970. Its first plane, the A300, a short- to medium-range twin-engine wide-body transport, went into service in May 1974. A smaller Airbus, the A310, was delivered to customers beginning in the spring of 1983.[88]

Table 66.—U.S. Exports of Commercial Transport Aircraft (33,000 lb and over airframe weight, 1978-82)

	1978	1979	1980	1981	1982
Total number exported	111	200	237	255	121
Canada	4	20	22	25	13
Latin American and Caribbean	14	19	31	35	13
Europe	36	68	109	108	31
Middle East	17	17	9	21	13
Asia	24	60	53	34	25
Oceania	6	6	7	19	8
Africa	10	10	6	13	18
Total value (millions of dollars)	$2,558	$4,998	$6,727	$7,180	$3,834
Canada	132	373	299	584	294
Latin America and Caribbean	187	423	640	1,027	301
Europe	906	1,601	2,670	2,528	938
Middle East	541	582	236	841	699
Asia	478	1,722	2,467	1,405	1,096
Oceania	118	149	179	559	234
Africa	196	148	236	236	272

SOURCE: Bureau of the Census, "U.S. Exports. Schedule B. Commodity by Country," Report FT 446 (annually), in Aerospace Industries Association of America, Inc., *Aerospace Facts and Figures 1983/84*, Washington, D.C., July 1983, p. 133.

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[86] Robert Bailey, "Boeing Strikes Back," *Middle East Economic Digest*, Feb. 3, 1984, pp. 34-35.

[87] The French Government owns more than 97 percent of Aerospatiale, the British Government holds 48.3 percent of British Aerospace's shares with the rest held privately. CASA is wholly owned by the Spanish Government. Deutsche Airbus is a subsidiary of two commercial companies that are in the process of merging.

[88] Richard C. Schroeder, "Troubled Air Transport Industry," *Editorial Research Reports*, vol. 11, No. 20, Nov. 26, 1982, p. 882.

Commercial aircraft, however configured, are costly, as shown in table 67. Enormous capital outlays are required for developing and producing new models of large commercial aircraft. A new airline program can cost $2 billion to $3 billion before deliveries even begin.[89] This figure may exceed the company's entire net worth.[90] There is no guarantee that even a best-selling plane will be a major revenue earner. Of 23 models of commercial jet-powered transports produced, only two are believed to have been profit-earners—the Boeing long-range 707 and the medium-range 727. (Over 1,800 727s have been delivered.) Lockheed's L-1011 lost $2.5 billion by the time it was canceled, after approximately 200 were delivered. The supersonic transport Concorde, developed by the British and French, was a technical success but a major financial failure; only 16 were produced.[91]

Boeing's newest planes are both twin-engine jetliners with new, fuel-efficient engines. The 767, a twin-aisle wide-body, smaller than the 747, began flying commercially in the United States in September 1982. It has seven seats across with a capacity of 211 passengers. The 757, under delivery beginning in 1983, is a short- to medium-range jet with 186 seats.

Some observers note that, until recently, no aircraft available on the market had 150 seats to accommodate a smaller number of passengers. This perceived gap in the market led aircraft manufacturers in the United States and Europe to begin work on a smaller airplane. This size is desired by airlines for its fuel economy.

Boeing disputes that the 150-passenger aircraft need must be filled by a completely re-

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[89] See ch. VI, "The Economics of Large Transport Development, Production, and Operation in the United States," *A Competitive Assessment of the U.S. Civil Aircraft Industry*, U.S. Department of Commerce, Industry Analysis Division, Office of Industry Assessment, March 1984.

[90] The decision to build a new jetliner has been referred to as "betting the company." See John Newhouse, *The Sporty Game* (New York: Alfred A. Knopf, 1982).

[91] Annabelle May, "Concorde—Bird of Harmony or Political Albatross: An Examination in the Context of British Foreign Policy," *International Organization*, vol. 33, No. 4, autumn 1979, pp. 481-508.

Table 67.—Typical Configurations and Purchase Prices of Various Competing Commercial Aircraft

Manufacturer/country	Model	Year available	Seating[a] (seating range)	Cost[b] (millions 1984 dollars)
Airbus Industrie				
France, United Kingdom, Federal Republic of Germany, Spain	A300	1974	260 (250-260)	50
	A310	1983	210 (200-210)	45
	A320[c]	1988	150 (134-174)	24
Boeing				
United States	737-200	1968	115	16-20
	737-300	1984	(122-149)	23-25
	737-400	under review	(134-161)	NA
	747-SP	1976	331	77-84
	747-200	1971	452	86-101
	747-300	1983	496	91-106
	757-200	1983	186	38-42
	767-200	1982	211	48-54
	767-300	1986	261	56-61
	7-7[d]	late 1980's	—	—
McDonnell Douglas				
United States	MD-80	1980	140(133-155)	23-24

[a] Number of seats depends on seat pitch (spacing) used. First number is for a typical layout.

[b] Costs are highly variable and are given as a reference only. Aircraft configuration, customer needs, provision of spare parts, and other factors make exact numbers for aircraft or cost comparisons between companies difficult.

[c] The Airbus A320 project received final go-ahead funding from the consortium in March 1984.

[d] The configuration of the 7-7 is unknown; it will probably make greater use of composites and may use a lighter weight metal skin.

SOURCES: "The Air War—Boeing, Airbus Fight for Jetliner Contracts All Around the World," *Wall Street Journal*, Mar. 20, 1984; information provided by Boeing Commercial Airplane Co., Airbus Industrie, and McDonnell Douglas Corp., March 1984.

designed (and hence very expensive) airplane. Their 737-300 model can accommodate a maximum of 149 seats.[92] Under study are a 737-400 configuration (a stretched version of the 737-300) with 134 to 161 seats, and a shortened version of the 757-200 (presently 186 seats). Boeing has recently reached agreement with the Japanese for development of a new plane, presently termed the 7-7, which could end up being in the 150-seat range.[93]

The Douglas MD-80 has 142 seats and might be stretched into the 150-seat range. The MD-80 series plane is already selling well in the United States and elsewhere, with three models in production (the Super 80, MD-82, and MD-83 seating up to about 155 passengers). This makes the aircraft already an effective rival in the 150-seat market.[94] McDonnell Douglas is now studying a new version, the MD-88, which would seat up to 164 passengers and use the projected new international V2500 engine being developed by the multinational International Aero Engines consortium.[95] The latter powerplant is being developed by a group of seven companies in five countries, with Pratt and Whitney of the United States and Rolls-Royce of the United Kingdom the project leaders. The engine is expected to be available around 1988 and probably will also be used in the Airbus A320.

The need for a new 150-seat jetliner was a major concern in the deliberations leading to approval of funding for the A320 by the separate members of the Airbus consortium.[96] The production go-ahead for Airbus Industrie's A320 Transport program (which will cost a total of over $2 billion) was endorsed by European governments under the condition that the consortium work to improve its profitability and more equitably distribute equipment contracts among participating countries. The 150-seat aircraft is expected to make its first flight in February/March 1987. Certification and start of deliveries are planned for spring 1988.[97]

Government Roles in Aircraft Sales

Competition between Boeing and Airbus is already intense and will probably become more so once the 150-seat A320 is introduced in 1988. Each company complains that the other enjoys unfair marketing advantages. Boeing argues that Airbus is subsidized by the participating governments, allowing it to provide preferential financing. Boeing also contends that nationally owned European airlines naturally prefer Airbus planes. Airbus refutes this by pointing to sales of the Boeing 757 to British Airways. As a response to charges by U.S. aircraft manufactuers, Airbus states that aerospace research undertaken by the U.S. National Aeronautics and Space Administration (NASA) and made available to American manufacturers, constitutes a subsidy for U.S. companies. Airbus also states that the U.S. Export-Import Bank devotes an inordinate amount of its resources to financing overseas aircraft sales. Boeing has the largest exports of any U.S. company, as shown in table 68.

One of the reasons given by the Europeans for their government support of Airbus is that European industry faces a fundamental problem in its lower volume of production in comparison to U.S. manufacturers. According to this view, long production runs give the U.S. manufacturers, particularly Boeing, economies

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[92] Germain Chambost, "Boeing's 737-300: A Step Into the 150-Seat Market," *Interavia-Aerospace Review*, March 1984, pp. 240-241.

[93] "Boeing, Japan Sign Work Share Pact for 7-7," *Aviation Week and Space Technology*, Mar. 19, 1984, p. 32.

[94] Michael Dixon, "McDonnell-Douglas Studying MD-80 Airliner Derivative," *Financial Times*, Mar. 16, 1984, p. 6.

[95] Ibid.; *Aviation Week and Space Technology*, Mar. 19, 1984, p. 31.

[96] During deliberations by the British, Margaret Thatcher was quoted as saying, "I don't want another Concorde. Where is the market?" (Peter Riddell, "UK Aid for Airbus—I Don't Want Another Concorde," *Financial Times*, Mar. 7, 1984). The British Government finally approved 250 million pounds in launch aid to British Aerospace for its share of the A320 project in early March 1984. British Aerospace argued that the A320 was not a technological breakthrough into an untested market like Concorde but an updated and improved version of the existing European Airbus project which would replace existing medium-range aircraft. Firm orders and options for the A320 number approximately 100. It is estimated that 600 must be sold for break-even, or more than 700 for the British Government to earn a reasonable return on its investment. (Ibid, Riddell.)

[97] Jeffrey M. Lenorovitz, "Europeans Endorse A320 Production," *Aviation Week and Space Technology*, Mar. 19, 1984, p. 29-30.

Table 68.—Ten Leading U.S. Exporting Companies

Rank	Company	Total sales[a] (in billions)	Exports[a] (in billions)	Percentage of sales
1	***Boeing***	$ 9.78	$6.10	62.4%
2	General Motors	62.69	5.72	9.1
3	***General Electric***	27.24	4.34	15.9
4	Ford Motor	38.24	3.74	9.8
5	Caterpillar Tractor	9.15	3.51	38.3
6	***McDonnell Douglas***	7.38	2.76	37.5
7	E. I. du Pont de Nemours	22.81	2.64	11.6
8	***United Technologies***	13.66	2.63	19.2
9	IBM	29.07	1.85	6.3
10	Eastman Kodak	10.33	1.80	17.4

[a] For 1981, as reported by *Fortune*, Aug. 9, 1982, p. 68.
Boldface denotes companies that are engaged wholly or partly in aircraft manufacture.

SOURCE: Richard C. Schroeder, "Troubled Air Transport Industry," *Editorial Research Reports*, vol. II, No. 20, Nov. 26, 1982, p. 883.

of scale which are extremely difficult for the Europeans to match unless they can secure a sizable share of the huge U.S. airplane market.[98] They note that out of 353 A300/A310 Airbuses ordered to date, a total of only 36 have been ordered by two U.S. airlines.[99] Viewing Airbus investments as very speculative, these observers argue that the bulk of the funding has to come from their governments.

For their part, U.S. aerospace industry leaders point out that U.S. aerospace companies fund a substantial amount of research and development (R&D) themselves. A National Science Foundation (NSF) analysis of industrial R&D shows that the aerospace industry's R&D funding far outpaces the average for all U.S. manufacturing industries. In 1981 aerospace company funding of R&D (civil plus military) was 4.2 percent of net sales, compared to 2.0 percent for all U.S. manufacturing industries. Total aerospace R&D funding (company plus government) was 15.3 percent of net sales while the comparable all-industry percentage was 2.9.[100] Figure 14 shows the Federal and company funds spent on aerospace R&D (civil and military) from 1970 to 1983 in current and constant dollars.

The issue of subsidization becomes more complex if one examines only the component of U.S. Government support for commercially oriented aeronautical R&D. The Federal Government, through NASA, devotes roughly $300 million a year to these commercial aeronautical R&D projects.[101] NASA supports long-term R&D in some areas that may be underfunded by private firms, such as aircraft noise and safety. Other programs support the development of more fuel-efficient and better performing aircraft, goals for which some feel private incentives may be adequate. On the other hand, some believe that there are no grounds for favoring this industry over others also facing international competition but receiving little R&D support. Advocates of NASA's support argue that reductions in these programs could have a negative effect on the international competitiveness of the U.S. civilian aircraft industry.

The federally supported U.S. Export-Import Bank (Eximbank) lends money at subsidized interest rates to foreign purchasers of U.S. products. The industries benefiting most from Eximbank's subsidized overseas lending in the last decade have been manufacturers of com-

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[98] "The Airbus Example," *Financial Times*, Mar. 5, 1984.

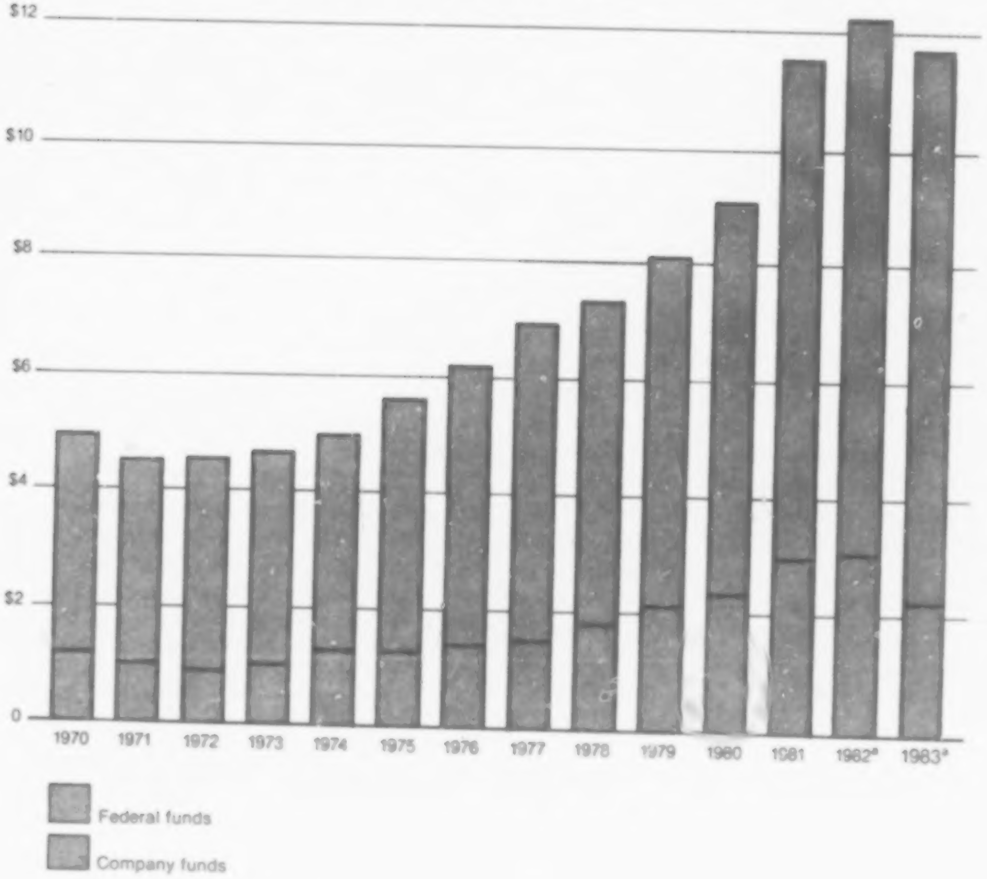
[99] Michael Donne, "U.S. Airbus Protests Arouse Little European Sympathy," *Financial Times*, Mar. 22, 1984. The Europeans also note that Airbuses have approximately 30 percent U.S. content by dollar value.

[100] Aerospace Industries Association of America, Inc., *Aerospace Facts and Figures 1983/84*, Washington, D.C., July 1983, p. 109.

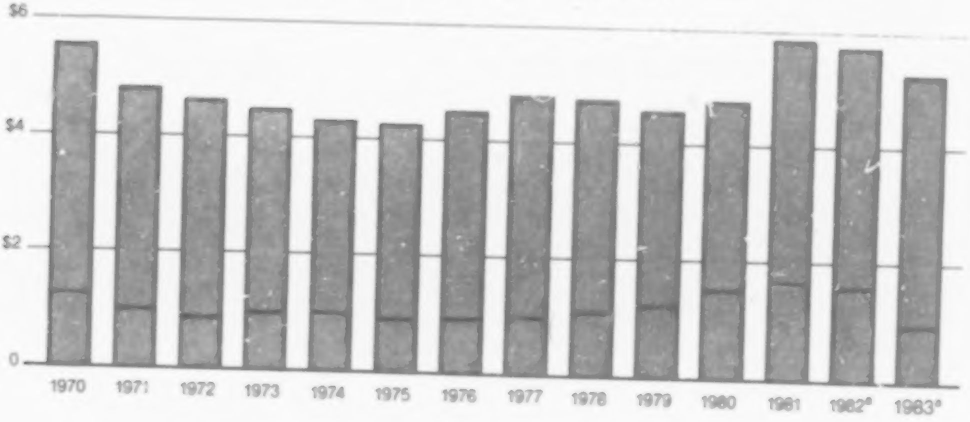
[101] *Reducing the Deficit: Spending and Revenue Options*, a Report to the Senate and House Committees on the Budget—Part III (Washington, D.C.: U.S. Congress, Congressional Budget Office (CBO), February 1984.) p. 173. CBO listed elimination of NASA's commercially oriented aeronautical R&D programs as one way to reduce nondefense discretionary spending. This one change, if adopted, could generate savings of $1.9 billion over the 1985-89 period, according to CBO estimates.

Figure 14.—Aerospace Industry Funds for Research and Development

(billions of current dollars)



(billions of constant dollars—1972 = 100)



SOURCE: *Aerospace Facts and Figures 1983/84*, Aerospace Industries Association of America, Inc., Washington, D.C., July 1983, p. 110

a: Estimate

mercial aircraft and heavy equipment, including power generators. The large share of loans for commercial jet aircraft exports from the Export-Import Bank is shown in tables 69 and 70. Table 69 lists total Eximbank authorizations of loans and guarantees as well as separate exports for fiscal years 1974-82. In the years 1979, 1980, and 1981, aircraft exports represented 37.3 percent, 41.8 percent, and 50.3 percent of total loan authorizations. This percentage, however, fell dramatically in 1982 to 7.8 percent of a much smaller total loan authorization of $3,104 million. Total authorizations for loans in support of aircraft exports in 1982 were less than one-tenth that of the previous year. Some of the reasons for the decrease were the soft market for aircraft sales during the worldwide air transport recession, lower total Eximbank funds, and questions as to which U.S. planes truly were up against unfair competition.[102] Table 70 gives a summary of commercial jet aircraft authorizations and the number of jets involved. The number of jetliner exports covered by these loans and guarantees fell sharply from 1981 to 1982.

Supporters of the Eximbank program maintain that it is a necessary response to the sometimes "predatory" policies of foreign competitors offering advantageous financing terms to attract and retain buyers. They also feel that export programs stimulate U.S. employment and promote development of technology. Critics contend that such programs are inappropriate interference in the free market causing economic inefficiency. They also criticize the programs on the

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[102] The Export-Import Bank determined that loans would only be provided in cases where U.S. exporters faced direct competition from foreign suppliers.

Table 69.—Export-Import Bank Total Authorizations of Loans and Guarantees and Authorizations in Support of Aircraft Exports (fiscal years 1974-82, millions of dollars)

		Authorizations in support of aircraft exports[a]			
Year	Total authorizations	Total	Percent of total authorizations	Commercial jet aircraft	Other aircraft[b]
Loans:[c]					
1974	$3,981	$ 946.2	23.8%	$ 894.6	$51.6
1975	2,701	710.4	26.3	691.2	19.2
1976	2,285	421.9	18.5	398.4	23.5
1977	747	139.0	18.6	137.6	1.4
1978	2,927	195.2	6.7	189.5	5.7
1979	3,825	1,427.7	37.3	1,399.4	28.3
1980	4,087	1,710.1	41.8	1,692.6	17.5
1981	5,079	2,555.0	50.3	2,550.3	4.7
1982	3,104	241.4	7.8	199.1	42.3
Guarantees:[d]					
1974	$1,594	$ 154.0	9.7%	$ 132.9	$21.1
1975	1,574	84.5	5.4	64.0	20.5
1976	1,661	107.6	6.5	87.2	20.4
1977	1,021	307.5	30.1	293.9	13.6
1978	589	97.6	16.6	77.2	20.4
1979	908	261.4	28.8	239.3	22.1
1980	2,510	1,131.9	45.1	1,088.1	43.8
1981	1,513	562.6	37.2	533.4	29.2
1982	727	104.2	14.3	78.4	25.8

[a] Includes complete aircraft, engines, and parts.

[b] Includes business aircraft, general aviation aircraft, helicopters, and related goods and services.

[c] Loans are commitments for direct financing by the Export-Import Bank to foreign buyers of U.S. equipment and services, including direct credits and loans authorized under the Cooperative Financing Facility (CFF), until the termination of the CFF program in 1981, but excluding Discount Loans, which are made by the Export-Import Bank to commercial banks and which subsequently may be guaranteed by the Export-Import Bank, in which case the value of the loans is included with Guarantees.

[d] Guarantees by the Export-Import Bank provide assurances of repayment of principal and interest on loans made by private lending institutions, such as commercial banks, for major export transactions.

SOURCE: Export-Import Bank of the United States, in Aerospace Industries Association of America, Inc., *Aerospace Facts and Figures, 1983/84*, Washington, D.C., July 1983, p. 136.

Table 70.—Export-Import Bank Summary of Commercial Jet Aircraft Authorizations for Loans[a] and Guarantees[b] (fiscal years 1957-82, values in millions of dollars)

Year	Number of jets		Export value		Number of credits		Gross authorizations	
	Loans	Guarantees	Loans	Guarantees	Loans	Guarantees	Loans	Guarantees
New authorizations:								
1957[c]-68	322	53	$2,572	$ 331	92	58	$ 1,520	$ 274
1969	55	23	451	207	23	18	197	111
1970	142	1	1,749	3	44	38	598	79
1971	126	9	1,539	40	58	49	481	363
1972	145	2	1,334	9	44	29	475	183
1973	129	4	1,729	25	60	23	690	191
1974	189	—	2,195	—	79	22	895	133
1975	136	1	2,070	5	64	10	691	64
1976	77	6	1,017	139	34	11	398	87
1977	31	25	330	902	16	14	138	294
1978	29	5	479	253	18	5	189	77
1979	118	7	2,938	317	35	10	1,399	239
1980	136	21	3,975	901	36	24	1,693	1,088
1981	121	18	4,568	637	26	17	2,550	533
1982	13	7	441	113	5	2	199	78
Cumulative new authorizations	1,784	187	27,603	4,064	640	333	12,208	3,853
Transfers and reversals	—	—	(8)	—	4	—	(24)	(20)
Cumulative gross authorizations (net of transfers and reversals	1,784	187	27,595	4,064	644	333	12,184	3,833

NOTE: Detail may not add to totals because of rounding.

[a] Loans are commitments for direct financing by the Export-Import Bank to foreign buyers of U.S. equipment and services, including direct credits and loans authorized under the Cooperative Financing Facility (CFF) until the termination of the CFF program in 1981, but excluding Discount Loans, which are made by the Export-Import Bank to commercial banks and which subsequently may be guaranteed by the Export-Import Bank, in which case the value of the loans is included with Guarantees.

[b] Guarantees by the Export-Import Bank provide assurances of repayment of principal and interest on loans made by private lending institutions, such as commercial banks, for major export transactions.

[c] First year of commercial jet aircraft authorizations.

SOURCE: Export-Import Bank of the United States, in Aerospace Industries Association of America, Inc., *Aerospace Facts and Figures 1982/84*, Washington, D.C., July 1983, p. 137.

grounds that they give an advantage to some firms over others, and create income transfers from taxpayers in the United States to assisted firms and also to foreign buyers.

These issues are complicated by the fact that complex buyback arrangements are not uncommon in jet airliner sales. The manufacturers do not disclose details of individual deals, but Boeing is understood to have an inventory of approximately 50 aircraft (including jets of other manufacturers) that it has either already bought back, or has agreed to acquire at a future date, in order to win new sales of its own jets. In another case of competition for sales in Kuwait, it was reported firms were proposing to buy back jets manufactured by their competitors and not yet delivered in order to win sales.[103]

High-level supplier government economic diplomacy has frequently been employed. The sale to Egypt of three Boeing 767-200 ER (extended range) worth $163 million was a particularly difficult one. Between the initial agreement in September 1983 and formal contract signing on January 12, 1984 (for delivery in July and August 1984), the governments backing Airbus reportedly instructed their ambassadors in Cairo to lobby Prime Minister Fuad Mohieddin to persuade EgyptAir to choose Airbus.[104] In a final but unsuccessful effort to thwart the Boeing sale, Aerospatiale's chairman, Henri Matre, was said to have offered Egypt a role in producing the airliners.[105]

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[103] Michael Donne, "Why Boeing is Buying Airbuses to Win Key Orders," *Financial Times*, Feb. 2, 1984, p. 5. These buybacks are reportedly sometimes at above market rates. In the battle between Airbus and Boeing for a Thai Airways International order for two planes, which Airbus eventually won, Boeing offered to purchase three old DC-8s from Thai Airways International at $5 million each. Airbus offered $5.1 million for each with spare engines. The market value for DC-8s is presently $2 million to $3 million. See William M. Carley, "The Air War: Boeing, Airbus Fight for Jetliner Contracts All Around the World," *Wall Street Journal*, Mar. 20, 1984, p. 1.

It thus appears that both U.S. and European manufacturers of commercial aircraft are being subsidized—but the extent of the subsidies, either direct (through subsidized loans) or indirect (through R&D programs or diplomatic support) are difficult to gauge. Both sides see the growth of government assistance as a response to the "unfair" practices of the other players. Boeing Commercial Airplane Co., as a private, for-profit business, must compete against Airbus, an essentially staterun business which is predicated on other factors in addition to turning a profit.

Because of continuing disagreements over subsidies, a special aircraft sector agreement was established in 1981 between the United States and major European countries to set clearer rules of the game in financing exports of commercial aircraft. This common-line agreement (subject to renewal every 6 months) sets a minimum interest rate and maximum cover for government agencies. Thus, in the past few years progress has been made to ensure that supplier governments adhere to similar rules of the game in financing exports of commercial aircraft.

Aircraft Engine Suppliers

Aircraft engine manufacturers have been involved in maintenance facilities in the Middle East. General Electric, for example, recently assisted Egypt in setting up an engine maintenance facility. This is a limited modular facility capable of expansion, but it is not now conducting major overhauls. Similarly Rolls-Royce is providing Saudi Arabia with engine overhaul equipment. The engine manufacturers play an important role in supplying equipment for local maintenance bases, but much of this equipment can be supplied by other types of firms involved in aircraft and engine maintenance. Chief among these are the major airlines.

Commercial aircraft engine manufacture and sales is a separate realm of competition. Ten years ago, the situation was fairly simple: Pratt and Whitney (U.S.) dominated the market and each plane model was matched with a specific engine from a specific company (almost always Pratt and Whitney). Today, the Pratt and Whitney Aircraft Group (a division of United Technologies Corp.) has two strong competitors: Rolls-Royce (U.K.) and the General Electric Aircraft Group (U.S.)[106] G.E. also has a joint venture called CFM International with the French corporation, Snecma.

Today, each of the new, more efficient airplanes, the Boeing 757 and 767 and the Airbus A300 series, can be fitted with engines from at least two of the manufacturers. In addition, a multinational consortium, International Aero Engines, is now developing the V2500 engine which will be able to power the A320 now under development (the A320 can also be powered by the CFM International CFM56-4). The fact that an airliner can now be built with engines from different manufacturers is important on two counts. First, it intensifies competition among the engine makers who may be willing to make concessions in order to win contracts for particular planes. Second, if an aircraft manufacturer feels that its sales may suffer because it carries a particular engine (e.g., U.S. controls on exports of U.S. engines prevented sales of Airbuses to Libya), the company may opt for another engine which does not present those risks.

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[104] Robert Bailey, "Boeing Strikes Back," *Middle East Economic Digest*, Feb. 3, 1984, pp. 34-35.

[105] Ibid.; also David Marsh, "France Offers Egypt Airbus Work in Bid to Beat Boeing," *Financial Times*, Dec. 6, 1983.

[106] Worldwide projected market shares for jet engines in the 1982-86 period are projected as Pratt and Whitney (36 percent); G.E. (30 percent); CFM International (23 percent); Rolls-Royce (9 percent); and other (2 percent), according to Forecast Associates, Inc. See Agis Salpukas, "Aircraft Engines: Stiff Rivalry—Pratt Loses Its Big Lead," *The New York Times*, Jan. 21, 1983, p. D1.

Competition among engine manufacturers, particularly in fast-growing markets such as the Middle East or Asia where an entry in the lucrative market is desired, has been hard fought. In competing for sales of the two new jetliners for Thai Airways International, the aircraft manufacturers and engine manufacturing groups that initially teamed up to bid later shifted sides.[107]

Airbus Industrie is becoming increasingly cautious about using U.S.-origin engines in their airframes. U.S. export controls reportedly delayed the sale of Airbuses to Libya.[108] The Airbus consortium therefore considered using engines made by Rolls-Royce as a way to circumvent the U.S. ban.[109] A study was carried out in 1983 by Airbus Industrie to determine what components would have to be changed on the A300 or A310 in order to export these aircraft to Libya.[110] The study indicated that Airbus aircraft include more than 30 percent U.S.-built content by dollar value (much of this due to U.S. engines), and that with such a high percentage of U.S.-built equipment, the aircraft are effectively under the restrictions imposed by U.S. export controls. Although the new A320 being developed may not be free of these restrictions since both available engines are partly U.S.-built, the Europeans talk of reducing U.S.-built content as much as possible so as to limit U.S. influence on Airbus export sales.[111]

The Airbus A320 will be powered by engines produced only partly in the United States—the CFM International CFM56-4—or the V2500 under development by the multinational International Aero Engines consortium. These engines are nevertheless subject to U.S. export controls. The fact that the V2500 falls into this category is of great concern to Rolls-Royce of the United Kingdom, one of the members of the engine consortium along with Pratt and Whitney of the United States. The U.S. Government has agreed to working-level discussions concerning the control of exports of the V2500 engine once it has been certificated. In return, Rolls-Royce has indicated that it will abide by U.S. export control restrictions on the engine.[112] As a result, the U.S. Department of Commerce issued export license authorization for the program on March 9, 1984. The British, however, are still concerned that U.S. export controls that may be administered in an extraterritorial manner. Rolls-Royce officials have stressed that their agreement was not a government-to-government one, and that they agreed to abide by U.S. export controls on the understanding that there will be serious negotiations on how the rules will be applied to the V2500 engine.[113]

Airport Systems

Airports in the Middle East are being expanded to accommodate increased air traffic in the region. Saudi Arabia recently completed airports at Jeddah and Riyadh and is planning another major development for Dhahran, as well as a number of regional airport projects.

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[107] See William M. Carley, "The Air War—Boeing, Airbus Fight for Jetliner Contracts All Around the World, *Wall Street Journal*, Mar. 20, 1984, p. 1. The real winner of this contest may have been the customer—Thai International. Thai's Senior Vice President, Mr. Lumholdt, was quoted as saying, "We got a wonderful deal—with all the concessions, we figure we got one $50 million airplane for free."

[108] David White, "Airbus Deliveries to Libya Delayed," *Financial Times*, Aug. 9, 1982.

[109] "Libyan Airlines Negotiates Airbus Lease," *Middle East Economic Digest*, vol. 26, No. 47, Nov. 19, 1982.

[110] *Aviation Week and Space Technology*, Apr. 4, 1983, p. 29, and Mar, 19, 1984, p. 31. See also Michael Donne, "Airbus Industrie Still Hopes To Sell Libya A300s," *Financial Times*, Apr. 26, 1984, p. 7.

[111] "U.S. Tries to Stem Airbus Business Loss," *Aviation Week and Space Technology*, Mar. 19, 1984, p. 31. Crawford F. Brubaker, Deputy Assistant Secretary of Commerce for aerospace who visited with government and aerospace-industry officials in Europe in March 1984, said he would not like to see a reduction of U.S. participation in the A320 program. However, he stated that there appeared to be a growing trend toward "de-Americanization, or, put the other way, the Europeanization of the A320." See also Jeffery M. Lenorovitz, "Europeans Endorse A320 Production," *Aviation Week and Space Technology*, Mar. 19, 1984, p. 29.

[112] Rolls Signs V2500 Export Plan," *Aviation Week and Space Technology*, Mar. 19, 1984, p. 32; See also *Aviation Week and Space*, Nov. 7, 1983, p. 30.

[113] Ibid.; *Aviation Week and Space Technology*, Mar. 19, 1984, p. 32. See also "Airbus Orders for Rolls-Royce," *Financial Times*, May 17, 1984, p. 8; and Keith F. Mordoff, "Airbus To Offer V2500 Option on A320," *Aviation Week and Space Technology*, May 21, 1984, pp. 33-34.

Abu Dhabi recently opened a new airport, and major work has been underway in Cairo and Baghdad. Algeria has more modest plans for upgrading and expansion.

Airport development in the Middle East has relied extensively on technical assistance and equipment from the West. This has been provided by a variety of firms including airport consultants, architects, airlines, construction firms, civil aviation authorities, aerospace manufacturers, and a multitude of equipment manufacturers. This scattering of activity among so many different types of firms makes it extremely difficult to analyze the factors determining commercial success in supplying and transferring the technical skills for the development of airport systems. Bechtel (U.S.) had the role of construction manager for the Jeddah airport project. The firm was responsible for up to 60 primary contracts at any given time since 1978. Some of these contracts involved extensive subcontracting; one reportedly involved 1,500 subcontracts with equipment suppliers. Yet public information on most of these contracts is not generally available. The bulk of the primary contracts are said to have gone to non-U.S. firms, but there is no way to document this. Although much of the actual equipment orders sourced through subcontracts reportedly have been won by U.S. firms, there is no way to verify this.

The civil aviation authorities of Western countries have been a major source of technical assistance in airport planning. France, the United Kingdom, and the United States have been the most active in this respect. Traditionally, such services were provided largely on the basis of colonial and historical ties, but today these links are less important. France actively seeks technical assistance relationships, and often assumes the costs under foreign aid. The United States responds to requests for assistance, which has been on a fully reimbursable basis since 1967. The United Kingdom pursues an approach similar to the United States, although it does occasionally assume the cost of technical services.

The actual implementation of airport development projects, such as those in Saudi Arabia, is normally carried out by groups of firms with separate contractual responsibilities. U.S. construction firms, Bechtel and Parsons, in joint venture with Saudi firms, are providing construction management services at Riyadh and Jeddah. The actual work and equipment contracts have gone to a multitude of firms from several countries, as mentioned above. In contrast to this type of multicontract international division of labor is the French approach of providing a comprehensive package which includes planning and design, construction, equipment installation, and even financing. This approach has reportedly enhanced the positions of French firms, as illustrated by the Cairo airport modernization work. This project began with a feasibility study by Aeroport de Paris in 1978, which included design of the terminal and construction supervision. Thomson-CSF supplied and installed the electronic equipment for the air traffic control system, and terminal construction was carried out by a French/Egyptian joint venture. Some financing was also made available through official export credits. This size of package would not have been sufficient to accommodate projects such as those in Riyadh or Jeddah. This approach does, however, allow for coordination of all facets of project development and implementation, which the French foster through this type of consortium.

Technical support in the operation and maintenance of airport systems is provided by a wide variety of firms. The Dhahran airport is operated by a services division of the Boeing Co. In other areas, technical assistance is provided by affiliates of airlines such as British Airports International, which has been active in the Gulf States, diversified aerospace companies such as Lockheed, which had a contract for the first phase of Saudi Arabia's air traffic control system, and equipment manufacturers. In Saudi Arabia, the major responsibility for operation and maintenance of the air traffic control system is handled by Bendix under a 1980 contract from the Presidency of Civil Aviation (PCA).

The case of the Bendix air traffic control contract illustrates factors influencing competition. Bendix won a contract in 1980, replacing the U.S. firm Lockheed. Bendix has overall responsibility for the air traffic control system, including staffing, equipment maintenance, training, and advising on new equipment for expansion. Logistical arrangement of the system is an important component of the contract, due to the variety of equipment types installed and the need to replace parts from many different countries. Bendix manages a training center in Jeddah, which has mockups of all the major systems in use. The major aim of the contract is to train Saudi Arabian nationals for eventual takeover. However, due to the shortage of qualified personnel, complete takeover by the Saudis is still a long time in the future. Bendix has over 1,000 foreign nationals under contract in Saudi Arabia, but some portion of these are in support services such as housing, transportation, etc.

Bendix did not have a proven track record in managing similar operations in other countries, but the firm did have 20-years experience with NASA projects in the United States. Its principal competition was from Lockheed and SEL, a German equipment manufacturer. Bendix had done extensive work in Saudi Arabia, for the navy and army, and was well known to the PCA. Primary factors affecting the contract award were reportedly price and the efforts of a well-placed Saudi agent. Bendix was the low bidder on the project, and also set forth an institutional arrangement and contract proposal which satisfied PCA's concerns about logistical functions and internal decisionmaking. Bendix met these concerns by establishing an autonomous division in Saudi Arabia capable of handling the logistical and other responsibilities. Bendix also emphasized training Saudi nationals as controllers and system managers.

The most important factors influencing airport systems contract awards appear to be a proven track record in the technology or technical management area, a demonstrated willingness to train nationals, the effective use of local agents or joint venture partners (especially in Saudi Arabia), historical relations with a country or firm, perhaps including the involvement of the civil aviation authority, and price/financing. In different countries, these factors are of differing importance: Saudi Arabia, for example, has been comparatively less concerned with price and is increasingly attempting to diversify suppliers.

Air Traffic Control/Avionics

Air traffic control (ATC) in the Middle Eastern countries under study ranges from Saudi Arabia's state-of-the-art system to Egypt's visual sighting. ICAO periodically publishes a status report for airport ATC throughout the world which lists requirements for raising major airports to ICAO international standards. In this publication, Middle East airports rate, as expected, from excellent to poor. Upgrading recommendations are generally for airfield lighting, markings, radio navigational aids, AFTN (Aeronautical Fixed Telecommunications Network), and AMS (Aeronautical Mobile Service-approach control). New aircraft such as the Boeing 757/767 and Airbus 300/310 come with the state-of-the-art ATC compatible equipment—but these are of no use if the airport does not have adequate ground ATC equipment, such as is the case in Egypt. Improved ATC enhances airline efficiency and safety and is thus a priority in airport modernization. Raytheon (U.S.), Bendix (U.S.), and Thompson-CSF (France) are major competitors in ATC equipment.

Aircraft avionics encompasses both ATC functions and aircraft systems monitoring. Collins Avionics (a subsidiary of Rockwell International) and ARINC (Aeronautical Radio Inc.) are leaders in aircraft monitoring equipment. Delco and Litton Industries, also from the United States, are the leaders in general inertial navigation systems with Honeywell specializing in laser-gyro based inertial reference systems. Major competition for U.S. firms comes from Thomson-CSF and Aerospatiale ATEC equipment, which supplies the Airbus. New digital equipment also is being manufactured by France's Sfena in cooperation with Great Britain's Smiths Industries and Germany's Bodenseewerk Geratechnik for the Airbus. Although avionics seems an ideal entree for Japanese electronics technology, Japanese firms have not yet entered into this field. Color cathode-ray tubes for crew-alerting systems are made by Toshiba and Mitsubishi, and Japan Aviation Electronics Industry, Ltd., is developing a laser-gyro inertial reference system for use in the Kawasaki XT-4 trainer. It is generally assumed that the Japanese will soon take significant steps into avionics, particularly digital systems.

Avionics will become dominated by digital systems (as opposed to analog) in the next few years, much as turbine engines largely replaced piston engines in large commercial transports. Digital systems are more expensive but more reliable (two to three times the mean time between failures) than analog systems. However, when they do malfunction, highly trained personnel with sophisticated equipment are needed to service them. Manpower requirements will thus shift even further to highly skilled technicians. At present, digital equipment manufacturers often give 3-year warranties which cover microprocessors and software modification. After that period, investing in spare parts for the equipment may be less expensive than developing digital maintenance expertise.

Aircraft simulators can cost up to $7 million each, $400 per hour to operate, and require highly trained personnel. However, when compared to the cost of actually flying a plane, the lifecycle cost savings are significant. Presently simulators are available for 13 commercial transport types and an equal number of smaller regional/corporate aircraft. Helicopter simulators are also available, although they are not as numerous. Major manufacturers of civil aircraft simulators include CAE Electronics, Ltd., of Canada, Conductron (U.S.), Curtiss-Wright (U.S.), Thomson-CSF (France), Redifon (U.K.), and Singer-Link (U.S.). Demand for simulators will grow as simulator "fidelity" (likeness to real-life) continues to improve.[114]

Private Aircraft and Helicopters

In addition to private travel within and outside some Middle Eastern countries, general aviation is used in air photography for oil and minerals, mapping, spraying, servicing of remote construction sites and drilling rigs, and for light freighting. Ownership of executive aircraft is concentrated in the Gulf area.

The use of private aircraft is limited by local problems. Many airports have a limited capacity for dealing with private aircraft, which will be expanded as airports are improved. In addition, because of security considerations, some governments have restricted registration of civil aircraft and individual aircraft movements.[115]

Among the smaller aircraft used by corporations, the Gulfstream, British Aerospace, Canadair, Falcon, and Lear models dominate the Middle Eastern market.

Helicopters are used to service oil derricks in the Gulf, worksites for fire control and first aid, such as at pilgrimage sites. Helicopters have been used to offload cement and steel pipe at Saudi ports and to lay pipe in the interior. Major suppliers in Saudi Arabia include: Agusta (Italy) primarily for military use, Bell Helicopter (U.S.), and Kawasaki (Japan).

Helicopter sales to the Middle East fell in 1982, although the downturn in world sales was sharper.[116] Nevertheless, the demand for helicopters in the Middle East has been fairly bouyant. It is estimated that 95 percent of the helicopters sold in the Middle East are for military uses. The largest helicopter sales at present in the Middle East are in Iraq (primarily due to the Iran-Iraq War) and Saudi Arabia.

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[114] See *ICAO Bulletin Special Issue: ATC and Flight Simulators*, vol. 37, No. 5, May 1982, for six articles on aircraft simulators.

[115] This assessment is found in "The New World of the Executive Jet," *Middle East Magazine—Aviation Survey*, August 1983.

[116] "Market Survey, Saudi Arabia," U.S. Department of Commerce, ITA, May 1981; "Building Up the Helicopter Fleets," *Middle East Magazine—Aviation Survey*, August 1983; "Saudis Expand Kawasaki KV-107 Helicopter Fleet," *Aviation Week and Space Technology*, May 21, 1984, pp. 150-151.

U.S. Export Controls

At the end of 1981, sale of Airbuses to Libya was restricted by U.S. foreign policy controls.[117] The sale of ten aircraft were blocked because they were to have General Electric engines. Six of the aircraft were not built. Four completed Airbuses destined for Libya reportedly remain at the Airbus production headquarters in Toulouse, France.

Table 65 shows the fleets of Middle Eastern airlines, including aircraft on order. While there is a preponderance of Boeing and Lockheed aircraft, reflecting the historical U.S. dominance in commercial aircraft, most aircraft on order are Airbuses. Indeed, Boeing has sold only three of its new generation aircraft (757 and 767). Airbus has made almost all sales of twin-engine, wide-bodied aircraft sales in the Middle East.

Opponents of foreign policy controls believe that these controls have strongly contributed to U.S. market losses in commercial aircraft sales in the Middle East. Potential buyers include countries designated as supporters of terrorism—currently Libya, Syria, and the People's Democratic Republic of Yemen—as well as other countries in the region that may turn to non-U.S. suppliers out of resentment of controls used for political purposes. Kuwait, for example, has urged other Gulf States to seek alternative suppliers of aircraft, in direct response to U.S. antiterrorism controls. The U.S. Department of Commerce cites such reactions as a partial basis for the reduction in sales of U.S. aircraft and avionic equipment in one of the largest and fastest growing markets in the world.

In testimony before the House Foreign Affairs Subcommittee on International Economic Policy and Trade on March 19, 1981, Mr. Harry Kopp, Deputy Assistant Secretary for Economic and Business Affairs in the Department of State, stated that:

> In no other area of the world were the successes of the competition so spectacular and our own sales performance so dismal as in the Middle East last year. Jet aircraft sales in the region climbed to $1,977 million, of which U.S. suppliers won only $259 million, or 13 percent, as compared with U.S. sales of over $1.5 billion the year before. Airbus, in contrast, selling $1.7 billion, captured 87 percent of the Middle Eastern market. . . . [Our] regional civil air attache in Tunis notes that the enormous decline in U.S. fortunes was not likely due to technical considerations, a lack of effort on the part of our manufacturers, not even to the quality of the airbus (sic). Rather, pivotal factors most mentioned by his contacts were: financing, political considerations, including foreign policy controls; high-level political support for Airbus; and the U.S. Foreign Corrupt Practices Act.

New orders for large U.S.-origin transport aircraft destined for the Middle East dropped from a peak of $1.1 billion in 1979 to $186 million in 1980, $380 million in 1981, and $89 million in 1982 (through September). On the other hand, Airbus orders for the same countries were $289 million in 1979, $1.2 billion in 1980, $484 million in 1981, and $661 million in 1982 (through September). Airbus orders for the Middle East totaled $2.3 billion during the 1980-82 period, compared with $655 million for U.S. aircraft.

Undoubtedly, various factors explain this shift in market share, including differing availabilities of export finance as well as a desire in the Middle East to diversify sources of supply for civilian aircraft. Because U.S. export controls in this area were uniquely restrictive, they contributed to the decline in the position of U.S. firms. The U.S. embargo of spare parts sales to Libya, especially, further added to the reputation of the United States as an unreliable supplier. For Middle Eastern countries whose positions differ with the United States on issues such as the Palestinian problem, such controls present a real potential risk that they may be denied access to U.S.-produced aircraft.[118] The recent modification of controls by U.S. officials to permit sales to scheduled airlines represented an effort to mitigate the adverse impacts of these controls.

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[117] David Marsh, "Airbus Components Plans Face Protests From U.S.," *Financial Times*, Mar. 21, 1984, p. 1.

[118] A Saudi manager recently said: "Another element [for Airbus selling so well in the Middle East/Persian Gulf area] is the political climate these days. Many Middle East countries want to reduce their reliance on the U.S. This should not be underestimated in evaluating Airbuses' sales success in the re-

Summary of Supplier Perspectives

Sales of large commercial aircraft are important both for the large dollar volume of aircraft sales and for the sales of auxiliary equipment, which includes testing and maintenance equipment, avionics packages, and spare parts. Planning, building, or operating airports, air traffic control, and navigation systems in the Middle East normally entail consulting or management contracts, a major area of strength for U.S. firms.

U.S. firms have led in commercial aircraft, avionics, and airport management. However, the stiff competition afforded by West European firms in each of these subsectors indicates that U.S. firms cannot count on continued technical superiority as the key to effective sales. Other factors such as low-cost bids, on-site support, and reputation for long-term supplier reliability may be critical in contract awards.

The main competition for aircraft sales in the Middle East presently is between the Airbus 310 and the Boeing 767. Industry experts note that neither one has a clear technical advantage over the other. While Airbus Industrie claims an edge in its avionics (aviation electronics), Boeing claims superior fuel efficiency. Both planes compete in the medium-range market, covering flights of 1½ to 5½ hours, which account for about 37 percent of departures worldwide. In the Arab world, this sector is expected to be worth $20 billion over the life of this generation of aircraft.[119]

Commonality of aircraft and engine type within an airline fleet is an important but not overriding consideration. If the price and financing terms offered by suppliers are similar, and future availability of spare parts is not a problem, in most cases airlines assemble mixed fleets.

In airport systems development a multitude of equipment manufacturers provide the various system components, often coordinated by construction management firms. For example, Bechtel has the construction management contract for the new Riyadh airport, but the equipment installation and construction is being handled under a number of separate contracts.

Supplier firms such as Thompson-CSF of France have special strength in supplying ATC and navigation systems. The United Kingdom is active in the Middle East commercial aircraft systems market, particularly in Saudi Arabia. West Germany's major presence has been in Iraq. The United States is primarily involved in Saudi Arabia.

Official diplomatic support (involving the use of official negotiating leverage to influence contract awards) is a factor in commercial aircraft support systems. However, relations among airlines such as the 30-year TWA-Saudia relationship, or the previous Pan Am-Iran technical assistance agreements, may carry more weight. The importance of government support has some relevance in airport systems contracts, but strong links are often established through technical assistance provided by civil aviation authorities.

Technological differentiation is limited among firms supplying equipment and services for commercial aircraft support systems. The technologies and equipment are fairly standard; many firms from several countries can provide adequate support. The basic technologies (although constantly improved) are relatively mature and well dispersed among the major industrial countries and even some newly industrializing countries such as Hong Kong (aircraft overhaul) and South Korea (airport construction). Indeed, India and Pakistan have been involved in airport construction in the Middle East (see tables in app. 7A). The standing and experience of the supplier firm is sometimes important, although aircraft operation and maintenance relationships are based more on initial provision of aircraft.

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gion," quoted in "Middle, Near East Airlines Increase A300/A310 Use," *Aviation Week and Space Technology*, May 14, 1984, pp. 47-49.

[119] "No Holds Barred in the Airbus—Boeing Battle," *Middle East Magazine—Aviation Survey*, August 1983.

The use of local agents is an important, sometimes required, means of winning aircraft support contracts throughout the Middle East. This has been especially the case in Saudi Arabia and Kuwait. While in the past, local agents have been used solely to garner political influence in bidding contracts, their role has generally expanded to involvement in assuring contract performance and maintaining continuing client relationships. Hiring well placed agents has been an important means of penetrating new markets for firms with little prior experience in a country.

Price is important in aircraft operation and maintenance, because of the routine nature of these services and the fact that they are current, not capital expenditures. Price and financing are becoming more important in the traditional oil-surplus countries, as the extensive development plans conceived in the 1970's progress into implementation while surpluses from oil revenues have diminished. Pricing and particularly financing arrangements have been important in commercial aircraft sales. Stiff competition for aircraft sales in the Middle East and the large future stakes believed to be involved have led suppliers to use, along with attractive financing, purchase incentives. These include buy-back of competitors' planes, package agreements for spare parts, training, or engine maintenance centers, or promises of assistance to the buyer's aircraft or even non-aircraft industries. These purchase incentives seem likely to continue in aircraft sales in the Middle East.

The expansion of foreign policy controls on U.S. exports of aircraft along with other types of export controls and regulations on U.S. business, have affected U.S. exports negatively. West European governments have subsidized the Airbus consortium; at the same time, the U.S. Export-Import Bank has supported sales of U.S. aircraft with loans. What distinguishes the policies of supplier governments is the absence of export controls in Western Europe, and their greater use of high-level economic diplomacy.

FUTURE PROSPECTS

In the short-term, the recipient nations will continue to carry out their commercial aircraft plans incorporated in their 5-year plans. For Iran this may be difficult; for Iraq, almost impossible. Saudi Arabia has the most ambitious plans and can be expected to complete its present airport infrastructure goals without major problems. Algeria has a fairly well-developed airport system, and its needs are more in the area of modernization and expansion than building new airports. Kuwait, with one major airport, will continue to consider a second airport. Egypt, despite major financing difficulties, will attempt to improve its existing airports and ATC systems.

In the long-term the world airline industry is expected again to prosper, and increased airline traffic worldwide in general and in the Middle East in particular, will provide a climate conducive to improved profitability. Freight transport in particular is expected to increase dramatically. All of this will place increased demands on Middle East air traffic control, airport management needs, and aircraft service. The Middle East countries will build on their positive experiences with technology transfer in this sector, and will eventually fully staff their commercial aircraft support systems with indigenous workers.

U.S. firms can be expected to maintain their leadership in the civil aviation sector in certain countries in the Middle East for the near term—however, U.S. firms can no longer rely on technological superiority. Aviation technology is becoming increasingly international.

IMPLICATIONS FOR U.S. POLICY

The importance of supplier reliability is especially evident in commercial aircraft support systems due to spare parts compatibility and training needs. The United States has gained the reputation of being an unreliable supplier, in large part because of U.S. export controls. U.S. export controls govern sales of commercial aircraft, in that sales can be restricted if countries are seen as supporting terrorist activities. These controls are used to impose sanctions on countries supporting terrorist acts. The military applicability of civilian technologies is, however, limited.

Equipment that can be used directly for military purposes includes radar capability, troop transport airplanes (e.g., C-130s), dual-use runways, and fuel storage and maintenance facilities. Concerns have been raised regarding applicability of commercial aircraft maintenance to military aircraft maintenance. However, maintenance, diagnostic tools, and training are vastly different for military aircraft that are not derivatives of commercial aircraft. While it provides a general base of knowledge in maintenance and repair, commercial aircraft training is not directly applicable to nonderivative military aircraft such as the General Dynamics F-16 air combat fighter or the Northrop F-5G. Military equipment, as compared to civilian, is built to different standards and requires different spare parts, and different maintenance training. Civilian helicopters are not easily used as military equipment, except for simple surveillance and transport. Thus, technically, there is little overlap between civil and military technologies and equipment. Some aircraft, however, do have both civilian and military uses, such as the U.S. C-130, or can be modified for military use.

Subsidies for manufacturers of commercial aircraft exist for both the United States and European rivals, either in the form of support for aircraft development, or subsidized loans. Diplomatic channels are often pursued by the Europeans in the form of trade missions by high-ranking government officials in order to promote sales, a route the United States does not often pursue.

Boeing and Airbus are engaged in intense competition, as illustrated by the Thai case mentioned earlier. In the Middle East, where many major purchasers of aircraft are less constrained by financial considerations than most developing countries, political factors have been particularly important in influencing sales. While it is often difficult, if not impossible, to identify the precise effects of politics on a particular sale, it is clear that the Europeans have in some instances benefited from their political support for Arab States. In contrast, strong U.S. support for Israel and the use of foreign policy export controls has undoubtedly served as an irritant to potential buyers in the Middle East. As a result, competitors are able to argue that the United States maximizes politics above trade, and recipient governments can point to purchases of comparable aircraft from non-U.S. firms as evidence of support for Arab positions.

The Airbus Industrie consortium, in its short 14 years of existence, has become a significant supplier. Although the consortium wants its aircraft to be profitable, motivations other than profits (employment, diversification of supply, technology development, prestige) are important, thus ensuring their continued support even if investors do not realize a favorable rate of return. U.S. policymakers must recognize that competition between Airbus and U.S. aircraft manufacturers, when carried out on fair terms, can be a good thing (for the companies and consumers alike). Enhancing, or even maintaining, U.S. market presence in commercial aircraft and aircraft support in the Middle East will be increasingly dependent on cost, financing arrangements, diplomatic support, and especially, consistent policies regarding export controls.

SUMMARY AND CONCLUSIONS

Each of the countries under study has a civil passenger airline (Kuwait Airways Corp., Saudi Arabian Airlines Corp., EgyptAir, Air Algérie, Iraqi Airways, and Iran Air) with the longest route miles being covered by Saudia and the shortest by Kuwait Airways. Operating statistics of these airlines (e.g., revenue passenger kilometers flown, revenue passenger loads, and average daily aircraft utilization) are comparable, in most cases, to those of other national flag carriers operating internationally.

The airlines of the Middle East have a preponderance of Boeing aircraft (707, 727, 737, and 747 in several variations), a smaller number of Lockheed L-1011s, and an increasing number of Airbus A300s and A310s. The airlines also have smaller planes such as the Fokker F-27, De Havilland DHC-5, and Hawker Siddeley 748. The average age for Middle Eastern jet aircraft is much lower than the world average for nonjet planes. All air carriers can perform routine maintenance and checks at their own facilities. Saudia, which had a comprehensive maintenance facility completed in 1979, can perform major overhauls as well. Aircraft engines for large commercial aircraft are manufactured by Pratt and Whitney, General Electric, Rolls-Royce, and CFM International.

All of the airlines rely on expatriate labor to some extent, with Kuwait and Saudi Arabia being the most dependent and Egypt and Iran being the least. The airlines are making efforts to reduce expatriate labor (e.g., Saudia has been successful in making one-half of its pilots Saudi nationals) but in the near term complete self-sufficiency will be difficult if not impossible to achieve—particularly among maintenance and overhaul personnel needed for Saudi Arabia's and Kuwait's airlines. Thus, Middle Eastern airlines will continue to need technical support in aircraft maintenance and operation from foreign sources.

The six countries under study have carried out significant airport development, with the efforts of Saudi Arabia being the most ambitious. Most major new airport construction is complete or near completion. Future plans emphasize upgrading existing airports rather than initiating new, expensive projects. Upgrading of a regional airport to handle international (wide-body jet) flights is planned for Saudi Arabia, Algeria, and Iraq. Upgrading of air traffic control is also planned for all but the newest airports. Major airport designers/prime contractors are all from the West and include Bechtel, Aeroport de Paris, and Hochtief. Actual construction work is, however, increasingly done by Korean firms. Future work will emphasize improvements in freight handling, airport access, runway expansion and strengthening, and construction of maintenance facilities.

Commercial aircraft support thus involves fairly well-defined, well-established technologies and technological processes which can, and have been, increasingly performed by indigenous personnel in the Middle East. The fact that the process of training indigenous personnel takes so long demonstrates that, even for moderately complex systems, technology absorption can be difficult and requires considerable efforts on the part of both recipients and suppliers. Despite the moves towards self-sufficiency in this sector in the Middle East, in some countries all aircraft operations may never become fully staffed by nationals. This is, however, not due to lack of capability on the part of local workers, but to a shortage of indigenous manpower willing to perform certain tasks, such as engine maintenance in Saudi Arabia or Kuwait. These two countries should be able to complete the expansion of their commercial aircraft support systems but will have to continue to use foreign workers at some levels. For Algeria, Egypt, Iraq, and Iran, the local labor force could support an expansion of commercial aircraft systems. Attention will have to be paid to the training of aircraft mechanics, in particular. Civil air traffic expansion is unlikely in Iraq or Iran while their war continues. Technology absorption in the commercial aircraft support systems sector can be expected to become more extensive in the years ahead, due to expanded facilities and training programs currently underway.

The fuller absorption of commercial aircraft support systems technology by the recipient Middle Eastern countries compared to other technologies in this study stems mainly from three factors: 1) a commitment on the part of the recipient governments to develop this technology for transportation infrastructure needs and for prestige; 2) the fact that training and performance in this sector are well defined by international standards; and 3) the relatively long experience with these technologies which are in some respects not as demanding as nuclear power or certain types of telecommunications systems.

Commercial aircraft support worldwide is becoming increasingly sophisticated and will require more highly trained personnel in the future. The heavy responsibility which comes with commercial airline support services with regard to human lives, invested capital, and reputation is a continued impetus to maintain high standards. The increased complexity of avionics systems, simulators, and air traffic control will ensure expansion of training throughout the world, not just in the Middle East.

Airline operations in the Middle East are generally on a par with internationally accepted standards except for air traffic control. Egypt is considered to have one of the least effective ground ATC systems in the world although it is now being improved. The ATC system of Iraq is also poor. Increased passenger and freight traffic will require modernized systems to maintain and improve airline efficiency in the Middle East.

Airport planning and construction has been performed primarily by expatriates, both working for private firms and international organizations such as ICAO and IATA. Construction has been managed by Westerners, with construction crews often from the Far East. Airport management in the Middle East has often been performed by nonnationals, particularly in the Gulf States where U.S. firms have been active. Indigenous personnel are being trained and will increasingly take over these operations.

The United States is generally acknowledged as a leader in avionics and aircraft engines. Increasingly, however, adequate substitutes are available for U.S. technology. The United States has recently been perceived as an unreliable supplier in the Middle East due to U.S. export controls, and more Middle Eastern countries are attempting to diversify suppliers. The Airbus, for example, uses U.S. engines and hence deliveries to Libyan Arab Airlines have been delayed due to U.S. foreign policy controls on exports to Libya. The Airbus consortium was considering recertifying the Airbus with Rolls-Royce engines (despite the considerable cost) in order to avoid such delays. That the new Airbus A320 will contain less U.S.- manufactured equipment appears certain, partly in response to concerns about U.S. export controls.

A major concern for U.S. aircraft manufacturers is the inroads the Airbus 300 (and potential inroads of the Airbus 310 after 1984) have made in the Middle Eastern market. The new fuel-efficient Boeing 757 and 767 have not been purchased extensively by buyers in the Middle East. Some say this is not because of the technical superiority or better after-sale service of the Airbus, but because the United States does not support aircraft sales financially or politically in the manner that the French sell the Airbus consortium. Through U.S. Government support for aerospace R&D in the form of export credits, however, the U.S. aircraft industry has been promoted.

U.S. export controls are also often cited as a reason for lack of new U.S. sales of aircraft in the Middle East region. Future sales of U.S. civil aircraft, and perhaps of aircraft engines in the growing Middle Eastern market are hindered by these controls, despite the aggressive sales techniques of U.S. manufacturers and the high quality of their products. Sales of export aircraft, plus their long-term attendant support services and spare parts, are a significant factor in the U.S. balance of trade and in U.S. employment. Other large markets which may eventually develop in Latin America and Africa could also be affected by the fear of potential purchasers that they might be subjected to future controls. While supporters of export controls see them as a means to exert pressure on countries supporting terrorist activities, policymakers must also take into account the commercial costs and the evidence that foreign policy controls do not appear to have by themselves resulted in change in the policies of foreign governments. Modification of present U.S. foreign policy control policies concerning commercial aircraft sold to foreign commercial airlines deserves serious consideration.

APPENDIX 7A: COMMERCIAL AIRCRAFT SUPPORT SYSTEMS: SELECTED RECENT CONTRACTS IN THE MIDDLE EAST

Table 7A-1.—Selected Recent Commercial Aircraft Support Systems Contracts in Saudi Arabia

Supplier country	Year	Supplier	Description	Amount (millions of dollars)
United Kingdom	1976	International Aeradio	Establish civil aviation training center at Jeddah	$ 30.0
Canada	1979	Air Canada	Maintenance contract for Saudia's Lockheed Tristars	2.0
United States	1980	Bendix Field Engineering Corp.	To supply system engineering, maintenance services and staff as well as operating air traffic control equipment and facilities at 31 airports. Also, supply training, automated data processing and recruitment services	337.0
United States	1979	Trans World Airlines	Technical assistance agreement to supply technical personnel to maintain Saudi aircraft and train Saudi nationals. Involved approximately 150 TWA personnel. Ran from May 1979 to December 1983	NA
United States	1984	Trans World Airlines	A continuation of the technical assistance agreement above. Runs from Jan. 1, 1974 to September 1986. TWA personnel involved begins at 150 and is gradually reduced to zero by the end of the contract.	NA
United States	1979	CRS Design Associates and Metcalf & Eddy	Design aircraft support facilities, project managment, site planning, construction documents.	10.9
France	1979	Union de Transports Aeriens Industries; Societe de Etudes Techniques and Enterprises Generales; Dumex-Batiment; Joseph Paris	Airport hangar construction and maintenance for royal family aircraft at Jeddah	
South Korea	1980	Dongsan Construction & Engineering Co., Ltd.	Construct telecommunications building, air cargo building, public safety complex, catering and central kitchen, fire station and other facilities at Riyadh International Airport.	205.0
Saudi Arabia	1980	Saudi Tarmac Co., Ltd.	Build terminal links to connect the four main terminals at Riyadh International Airport.	84.1

SOURCE: Office of Technology Assessment.

Table 7A-2.—Major Projects and Sources of Investment, 1971-81: Commercial Aircraft Support in Egypt

Source of funds	Project	Foreign nations involved	Contractors	Produce	Year started	Level expenditures	Comments
—	Cairo airport expansion	—	—	—	—	$150 million	Not a U.S. company
World Bank	Luxor airport	—	—	Study	—	—	—
—	Imbaba airport (Cairo)	United States	—	Upgrade to international capability	—	—	USAID feasibility study requested
—	EgyptAir engine shop	United States	General Electric	Overhaul aircraft engines	—	$14 million	Turnkey project
French government 8-9%, 10-year term	Commercial aircraft radar system	France	Thomson-CSF	Radar control system	1981	—	Expected to be signed soon
U.S. foreign military sales credits	Benha Factory (No. 144)	United States	Westinghouse	TPS-63 military radar	—	—	Licensed production under discussion

SOURCE: Office of Technology assessment.

Table 7A-3.—Major Projects: Civil Aviation in Algeria, 1979-82

Description of projects	Clients	Contractor	Location	Value of contract	Year
1. Design of pilot training centers	Ste. Metall-urgique Rias-Bajas	Tractionel (Belgium)	Thenia	Not stated	1981
2. Supply of Boeing 737s and 727s with Pratt and Whitney engines	Air Algérie	Boeing Co. (United States)	—	$35 million	1981
3. Supply of six C-130 Transport aircraft	Air Algérie	Lockheed (United States)	—	$100 million	1981
4. Design of airport with 3,000 meter runway	Air Algérie	Uvaterv (Hungary)	Tiaret	Not stated	1981
5. Supply of three Hercules L100-300 aircraft	Air Algérie	Lockheed (United States)	—	$30 million	1981
6. Turnkey contract to design and build airports	Air Algérie	International Airport Authority (India)	Setif and Batna	$100 million	1982

SOURCE: Office of Technology Assessment.

Table 7A-4.—Selected Recent Commercial Aircraft Support Systems Contracts in Iraq

Supplier country	Year	Supplier	Description	Amount (millions of dollars)
Austria/West Germany	1980	Universal Hoch and Tisfbou/Bilpinger and Berger and Strabag Bau	Construction of Basra Airport	$586.0
France	1979	Spie Batignolles and Fougerolle	Construction of Baghdad International Airport	900.0
Japan	1976	Pacific Consultants International	Study and design airport extension	4.3
Pakistan	1981	FEEDIA Agency	Supply of foreign labor for airport construction	NA
United Kingdom	1981	British Airports International	Provision of training courses	1.3
United Kingdom	1981	International Aeradio	Provision of training courses	0.53
United States	1981	Boeing	Supply three Boeing 727s and two Boeing 747s	183.6

SOURCE: Office of Technology Assessment.

Table 7A-5.—Selected Commercial Aircraft Support Systems Contracts in Iran

Project, its main characteristics	Total investment size	Year established	Domestic partners	Foreign partner(s) and other details
1.Aircraft refueling vehicles	316,000	1970	Iran Air	British firm—to provide lightweight aircraft refueling vehicles and trailers
2.Boeing 737s	$ 18.5 million	1970	Iran Air	3 Boeing jets
3.Concordes		1972	Iran Air	Preliminary order for 2 British-French Concordes
4.Boeings	$ 19.6 million	1973	—	2 planes (707, 737), with Eximbank loan of $7.45 million
5.Boeings—for oil	$ 60.0 million	1973	Government	Six 707s to be purchased and paid for by Iran in oil. Eventually canceled
6.Boeing jets	$103.0 million	1974	—	Purchase of three 727s, two 747s. Partially financed from a $45.3 million loan by Eximbank
7.Cargo and passenger jets	$ 99.0 million	1975	—	Contract for six 747s, two adapted for cargo and passengers
8.Boeing 747s	$ 49.5 million	1975	—	Three additional jets
9.Concordes		1975	—	Order for two British-French Concordes. Eventually canceled prior to delivery
10.Boeing	$200 million	1977	—	Aircraft provided by Boeing
11.Boeing 747s	$250+ million	1978	—	Five 747s (4 747-100Bs, 1 747 SP)
12.Airbus jets	—	1978	Iran Air	6 Airbus A-300s, to be delivered between 1979 and 1981. Two leased
13.Airport Lighting	$100,000	1978	Government	Runway lighting systems for Mehrabad Airport, Tehran, Provided by Sylvania division of GTE
14.Boeing Commercial Aircraft Corp	—	—	Government	Airport maintenance, training, and airport construction
15.Other airport support systems	—	—	Government	Northrop, Grumman, Sperry Univac, Hughes, Ford, E-Systems, Teledyne, Pan American, Rockwell Int., DH Canada, British Aerospace (Hawker Siddeley), United Technologies, Fokker, Lockheed, McDonnell Douglas
16.Pan Am—Iran Air Technical Assistance agreement	—	1963-78	Iran Air	Pan American World Airways; Ongoing technical assistance agreement to provide training and personnel for maintenance and operations of Iran Air fleet
17.Suppliers of light aircraft to Iran	—	—	—	Piper Aircraft (U.S.), Cessna Aircraft (U.S.), Beechcraft (U.S.), Hawker-Siddeley, Ltd. (U.K.)
18.Suppliers of ground avionics equipment	—	—	—	Hallicrafter Co. (subsidiary of Northrop (U.S.)), Collins Radio Corp. (division of Rockwell International (U.S.)), Stancil-Hoffman (U.S.), Marconi Electronics, Ltd. (U.S.), Harland-Simons (division of Simons Engineering Ltd., (U.K.)), Standard Telephone and Cables Ltd. (U.K.), Siemens (FRG), Redifoss Ltd. (division of British Electric Tractron Co. Ltd. (U.K.))

SOURCE: Office of Technology Assessment.

CHAPTER 8

Technology Transfers in Medical Services

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CHAPTER 8

Technology Transfers in Medical Services

INTRODUCTION

During the last 10 years, most Middle East countries and particularly those focused upon in this study, have placed increasing emphasis on improved health care. This emphasis has been reflected in both budgetary and public policy plans. The strides made in medical care during this period have been enormous, but much remains to be done. Some of the major health problems today involve diseases that have largely been conquered in the industrial countries, such as infectious and parasitic diseases, respiratory infections, problems related to childbirth, and diarrheal disease. Chronic diseases, such as heart disease, which have become common in the industrial countries and to which much of the newer medical technology is addressed, are, by many accounts, far down on the list of health problems in the Middle East. Many Middle Eastern countries need comprehensive public health programs to help meet their goals.

Of all the technology transfer sectors examined by OTA in this study, medical service transfers are those most likely to affect directly the quality and longevity of life of the average citizen in the Middle East. Since these transfers entail the promise of substantial improvement in local living conditions, U.S. Government programs supporting medical technology transfers are particularly prominent. However, medical services are also big business; U.S. firms have been important exporters of medical equipment and services, particularly in the hospital management area. Therefore, both the development assistance and commercial aspects of medical service technology transfers may have important implications for public policy.

The medical services sector covers a broad range of activities, from design and construction of medical facilities, to training of personnel, to management of varied types of health care. The large increase in petroleum revenues, the increased commitment to health care demonstrated in national development plans, and increased public health needs and expectations have converged to cause a rapid expansion in medical services technology transfers in the Middle East in the past decade. Saudi Arabia, for example, is one of the world's largest importers of medical equipment and hospital management services. Although decreased petroleum revenues may slow the region's pace of growth in this sector, increasing medical needs and the commitment to improve health care will continue, with effective technology transfer a major factor. Trends indicate an increased emphasis by recipients on local level preventive health care, as opposed to more costly, sophisticated curative care. Training of indigenous personnel at all levels and proper specification and maintenance of equipment will be the recipients' major concerns. Expatriate personnel may be required well into the future to fill personnel requirements in some medical services categories, particularly if the ambitious health care plans of some Middle Eastern countries are implemented.

An extremely significant aspect of medical technology absorption is the ultimate benefit to the patient. In the absence of direct indicators of this benefit, several dimensions of the health infrastructure in each country are used as proxies. A number of factors relevant to assessment of absorption of medical services technology are considered, including facility design and construction, equipment, staff, education and training, and research and development (R&D) programs. The number, quality, and capability of health personnel involved in the five areas are investigated. The level of medical technology absorption in the Middle Eastern countries under study is found to vary widely by country and medical service category.

U.S. firms have established strong positions in medical services in the Middle East, but the U.S. market share may decline, particularly in the medical equipment field. This is primarily due to their poor reputation for after-the-sale maintenance and service. The U.S. position is expected to remain strong, however, in hospital management contracts, since U.S. firms have a reputation for efficient operation and U.S. medical practice is highly regarded in the Middle East. In the future, however, the most pressing need will continue to be in the area of preventive and less sophisticated health care. U.S. development assistance programs have focused on health care of this type.

This chapter examines the nature and extent of technology transfer to the Middle East in the medical service sector. It examines the medical technologies and services involved and evaluates the development plans and strategies of various Middle East nations for improving medical services. It outlines the factors that influence sales of equipment and services, as well as the success of government-supported medical technology transfer. Finally, implications for U.S. policy are outlined.

MEDICAL SERVICES IN THE MIDDLE EAST

MEDICAL REQUIREMENTS AND FACILITIES

There are many types of "health care" and several ways to arrive at this care. Primary care is often associated with local village needs as well as preventive medicine. Secondary and tertiary care are more frequently associated with curative medicine and often comprise what is considered "modern" medicine. There is a need for proper integration of health care systems. Private medical care in developing countries usually comprises a small percentage of total health care. Government health ministries decide the countries' medical priorities and set the policy for the mix and emphasis to be placed on various types of health service.

Profile of Medical Services and the Medical Services Industry

Medical care is a large and diverse industry with no clear boundaries separating it from related sectors of the economy. In industrialized countries the health care system includes a wide variety of facilities and personnel totaling up to 10 percent of the total economic activity of the society.[1] In developing countries, the delivery of health care interrelates strongly with other factors such as food and nutrition, sanitation, water supply, literacy, and income distribution. In general, government is the main provider of health care; social insurance schemes are viewed as a public responsibility.

In industrialized countries the health care sector relies heavily on highly trained professionals and sophisticated facilities, although more than half of the workers are support personnel with little or no advanced medical training. In developing countries, various options exist for developing a medical labor force that relies to varying degrees on highly trained professionals. Generally, developing countries rely less on advanced personnel and facilities, both because of the shortage of available personnel and capital and because of the urgent need to deliver basic primary health care (with an emphasis on prevention) to low-income groups.

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[1] U.S. Census of Service Industries, 1978; For discussions of measurement of health personnel, see Robert Kohn and Kerr L. White (eds.), *Health Care: An International Study* (London: Oxford University Press, 1976); Milton I. and Ruth J. Roemer, *Health Care Systems and Comparative Manpower Policies* (New York: Marcel Dekker Inc., 1981).

Thus, two models can be used to characterize this broad technology area: 1) the "developed" country model, which relies heavily on hospital care, fully trained doctors, and an extensive pharmaceutical industry; and 2) the "basic health care" model (as in China), which relies heavily on larger numbers of health care workers with minimal training. A "mixed model" is prevalent in many developing countries.

Medical Service Categories

Medical services include the following categories, which may be emphasized to different extents in various countries:

1. *Hospitals.* Specialized facilities for health care, including physician and nursing services.
2. *Specialized clinics.* Dental, vision, and mental health services, in addition to other nonphysician services such as care of patients by midwives.
3. *Special health programs.* Examples include public health education, nutrition programs, sanitation programs, birth control campaigns, environmental health programs, and immunization programs.
4. *Medical training and education.* Training of health personnel, ranging from short training programs to the operation of medical schools and teaching hospitals.
5. *Pharmaceuticals.* Includes the distribution of medicines to patients and in some cases the manufacture of those medicines, and possibly R&D of new medicines. (This chapter does not deal extensively with the pharmaceutical industry, but treats it where necessary to understand the quality of services provided through medical facilities and personnel.)
6. *Administration.* Management for health facilities and administration of health programs.

Manpower Characteristics

As a point of reference, medical services in the United States illustrate the characteristics of health personnel in an industrialized country. It should be noted that exact definitions of these characteristics are not possible because there is no agreement as to exactly which personnel should be included in the category "health personnel" (i.e., those actually trained in medical work, those performing supporting roles, etc.).

In the United States, total expenditures for health services represent a considerable portion (about 10 percent) of GNP, with these expenditures concentrated in labor inputs. Of the total value of health services, about two-thirds represents labor input, one-sixth inputs of physical capital, and the remaining, one-sixth, goods and services purchased from other industries.[2] Among health care personnel in the United States, physicians and nurses make up the largest contingent of professional workers, together accounting for almost 40 percent of the total. In contrast to the situation in many developing countries, the majority of physicians work outside the hospital. Nurses make up by far the largest single group of U.S. health personnel, or about 30 percent of the total. Nursing aides and orderlies constitute nearly one-fourth of the direct health care workers in the United States.[3] Improvements in health technology have also necessitated an expansion of "allied health personnel," such as pharmacists and technicians.

In order to compare the situation in the United States and other industrial nations to that in the Middle East, several measures can be used to assess the amount and type of health personnel in a country. One measure is the number of physicians per capita. Although this measures only one component of the health system, it is generally available and gives a first approximation of health resources. Care must also be exercised in that definitions of what constitutes a "physician" in various countries may differ. Typical levels of "population per physician" (and the equivalent measure of physical infrastructure, population per hospital bed) for six Middle Eastern countries and representative developing and industrialized countries are presented in table 71.

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[2] In fiscal year 1974-75, it was calculated that total U.S. expenditures for health services reached $118 billion, or about 8 percent of GNP. See Alan L. Sorkin, *Health Manpower* (Lexington, Mass: Lexington Books, 1977), p. 1.

[3] Ibid., p. 6.

As the data indicate, there is over a hundredfold variation between levels of physicians per capita in the richest and poorest countries. In the Islamic Middle East, only Kuwait approaches the "level" of health care of industrialized countries. (However, there are also substantial variations within industrialized countries, which do not necessarily correlate with health levels of the population.[4]) Measures such as population per physician or per hospital bed have been criticized as inadequate for assessing health care delivery. In the considerable literature on the measurement of health personnel resources[5] are studies that have measured the use of health resources (e.g., frequency of visits to physician) or the actual levels of health of the population (e.g., longevity and mortality data) rather than number of physicians.[6] The socioeconomic standards are also important determinants of health care. Basic availability data such as that in table 71, however, continue to be the most widely used measurements of health personnel and facilities.

Table 71.—Population Per Physician and Per Hospital Bed

Country	Year	Population/ physician	Population/ hospital bed
Algeria	1977	5,592	387[a]
Egypt	1976/77	1,043[a]	479
Iran	1974	2,586	650
Iraq	1977	2,250	496
Kuwait	1977	784	257
Saudi Arabia	1977	1,641	647
Peru	1977	1,556	547
China	1978	2,602	503
Nigeria	1976/77	14,344	1,248
Ethiopia	1977	73,191	3,314
United States	1977	569	159
Japan	1976/77	845	94
Sweden	1976	561	67

[a]Estimates based on latest available data.

SOURCE: United Nations, *Statistical Yearbook, 1979/80*, pp. 843-851. Population/physician is based on total (indigenous plus expatriate) physicians practicing in the country.

Types of Technology Transfers

For Middle Eastern countries, the most important types of technology transfers involve imports of medical hardware and supplies, imports of services needed for construction, and staffing and management of hospitals. In the Gulf States, where there is limited local production of medical equipment and shortages of skilled medical personnel, turnkey hospital construction and the purchase of hospital management services have been utilized. One important facet of technology transfer involves training of local professional staff; another involves assistance in health care planning. In contrast, in Egypt there has been little use of international hospital managment firms, extensive participation of domestic firms in hospital construction, and reliance on bilateral foreign aid and technical assistance projects in the health field. Thus, there is a wide variety of types of technology transfers in the medical service sector in Middle Eastern countries. While government health ministries are everywhere central actors on the recipient side, supplier firms independently transfer technology to Gulf States. Assistance programs are also a major mechanism in Egypt and Algeria. In all of these countries, medical services technology transfer spans those needed for small-scale rural clinics to the most technologically advanced hospitals, as the next section indicates.

THE STATE OF MEDICAL CAPABILITIES IN THE MIDDLE EAST

Judging by factors that affect medical technology transfer, the six countries under study

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[4] Milton I. Roemer and Ruth J. Roemer, *Health Care Systems and Comparative Manpower Policies* (New York: Marcel Dekker, Inc., 1981).

[5] See, for example: Brian Abel-Smith, *Value for Money in Health Services* (New York: St. Martin's Press, 1976); Eli Ginzberg, *Health Manpower and Health Policy* (Montclair, N.J.: Allanheld, Osmun & Co., 1978); Milton I. Roemer, *Health Care Systems in World Perspective* (Ann Arbor, Mich.: Health Administration Press, 1976); U.S. Department of Health, Education, and Welfare (Office of International Health), *Guidelines for Analysis of Health Manpower Planning*, prepared by E. H. White Co., San Francisco, Calif. (Rockville, Md.: Office of International Health, 1979).

[6] Robert Kohn and Kerr L. White (eds.), *Health Care: An International Study*—Report of the World Health Organization (London: Oxford University Press, 1976).

Table 72.—Summary of Health Indicators and Health Sector Organization

Country	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Saudi Arabia	2.1%	$12,600	$117	25%	120%	7.3	111	55	64%	860	74%	1,640	8%	Blindness (trachoma), diabetes, polio, lung and breast cancer, TB, malaria, cholera, maternal and infant mortality	MOH, MODA, National Guard, ARAMCO, private
Kuwait	1.6	20,900	154	60	over 100	5.9	33	70	89	230	77	590	16	TB, infectious hepatitis, gastroenteritis, bilherzia, heart disease, cancer	Ministry of Public Health, Ministry of Defense, Ministry of Interior, private
Egypt	2.2	650	6	44	117	4.8	110	57	66	470	83	970	90	Diarrheal disease, bilharzia, polio, respiratory disease	Ministry of Health, other Ministries and Universities, Public and private sectors
Algeria	1.3	2,140	23	35	101	7.3	114	56	77	340	85	2,650	60	Infant mortality, diarrheal disease	3 Government Ministries: MOH (85%) (31 Wilayas), Ministry of Defense (160 Dairas), Ministry of Higher Education. Also: Social Security Organization, National Health Institute, Sonatrach and other state-owned corporations have their own
Iran	1.5	2,160[a]	23	50	81	6.0	105	58	51	650	41	2,320	65	Dysentery, TB, whooping cough, measles, malaria	Ministry of Health (over 50%), University Police, Military, Social insurance, private
Iraq	0.6	1,550[a]	8	26	111	7.0	76	57	62	480	94	1,790	40	Malaria, trachoma, bilharzia, TB, whooping cough, chicken pox	MOH—5 departments, 18 Governorates handle all but military, small private
United States	3.3	12,820	259	99[b]	139	1.8	12	75	100	150	36	520	77[c]	Chronic disease	Many variations

(1) Percent of GNP on public health expenditures
(2) GNP per capita, 1981
(3) Per capita public health expenditures
(4) Adult literacy percent
(5) Percent calorie supply as percent of requirement
(6) Total fertility rate (average number of births per woman over her lifetime)
(7) Infant mortality rate per thousand (aged 0-1)
(8) Life expectancy at birth
(9) Percent of population with access to safe drinking water
(10) Population per hospital bed
(11) Percent Government hospitals
(12) Medical density (people/physician)
(13) Percent indigenous physicians
(14) Medical problem areas
(15) Health sector organization

SOURCE: The World Bank, *Health Sector Policy Paper*, February 1980; *World Development Report* 1982 and 1983.

[a] 1977 figures.

[b] Care must be excercised in defining literacy. For example, in the U.S., experts state that 1 percent of the population is completely illiterate but that up to 20 percent are functionally illiterate, i.e., not having the reading and writing skills necessary to function adequately in our complex society.

[c] 1981 figure which is based on active foreign medical school graduates in the United States versus total active doctors of medicine in the United States. Foreign medical graduates excludes graduates of Canadian schools. Total active excludes Federal service. Note that foreign medical school graduates may be U.S. citizens. In 1981, 16.6 percent of newly licensed physicians in the U.S. were graduates of foreign medical schools. See *Statistical Abstract of the United States-1984*, U.S. Dept. of Commerce, Bureau of the Census, Washington, D.C., 104th edition, 1984, p. 109.

can be broadly categorized into three groups: 1) countries typified by substantial capital, rapid development, and a small indigenous population, such as Saudi Arabia and Kuwait; 2) countries with less capital, more population, and quantitatively larger trained medical cadres and infrastructure, such as Egypt and Algeria; and 3) countries whose extensive medical services plans have been halted or greatly decreased in scope because of civil strife or war, such as Iraq and Iran.

Table 72 summarizes the health status of the six countries and gives information on the United States for comparison. The brief descriptions presented next on the medical sector organization and health status of the six countries are not meant to be all-inclusive. They do demonstrate, however, the diversity of health sector organization, medical personnel resources, facilities, and types of health care in the Middle East. They also show that, given these differences, there is no preferred avenue toward improved health. Although many problem areas remain, great strides have been made in medical services in the last decade in most of the countries—partly due to increased oil revenues, but especially due to an increased commitment to improved health care, education, and living conditions by the respective governments.

Saudi Arabia

The development of modern hospitals and other medical facilities was among the most outstanding achievements of the second plan covering 1975-80. Saudia Arabia differs from most Western markets in that it has no medical equipment production of its own, is far away from medical supply and instrument producers, is a large country with a low population density, and has a small indigenous manpower force to draw on.

In Saudi Arabia various organizations are independently involved in health care services. They each have their own financial appropriations, staff, and facilities. At present, there is little coordination of their respective activities. The greatest responsibility for health organization and for the improvement of health in the Kingdom rests largely, but not completely, with the Ministry of Health (MOH), which operates 65 hospitals and about 1,000 dispensaries, health centers, and specialized facilities. In addition, 13 agencies (plus the private sector) offer health services for their employees and their dependents or are responsible for specialized health services. Among the most important of these are the Ministry of Higher Education, with responsibility for the medical colleges and teaching hospitals; the Ministry of Interior, for medical service for the police force, and the Ministry of Defense and Aviation (MODA). In addition, the National Guard has more than 10 hospitals and several clinics.

The majority of hospital beds are concentrated in the large cities, particularly Jeddah and Riyadh; preventive care is inadequate in many more remote communities. One of the aims of the third plan is therefore to provide the population in every region with improved facilities and medical service. Preventive health care is still largely neglected, especially away from the large towns. This lack of preventive care is one of the factors leading to an overload of the MOH hospitals.

The small number of nursing staff, medical administrators, and technicians together with the limited number of doctors constitutes an acute shortage of staff. The most serious problem is the low percentage of Saudi medical staff: according to some experts only 8 percent of the physicians and some 5 percent of the allied health personnel are Saudis—and most are naturalized Saudis.[7] The policy of the Saudi Government to decrease the dependence on expatriate medical staff and administrators has led to a shortage of personnel in several hospitals. The shortage of indigenous staff will no doubt slow the pace of hospital construction and staffing and will lengthen the time before Saudis can effectively take over their medical systems. This manpower shortage constitutes one of the most important constraints on medical technology transfer in Saudi Arabia.

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[7] Estimates of numbers of Saudis and non-Saudis vary. The 8 percent figure is based on combined estimates of U.S. experts in the medical services field. Saudi estimates for 1980 for numbers of non-Saudi physicans working in the Ministry of Health were considerably higher. See Ministry of Health, Saudi Arabia, Statistics Department, *Statistical Review* (1971-80).

Recently, Saudi health care standards have greatly improved, but the country still clearly faces a number of medical problems that are not unusual for a rapidly developing country.[8] The most prevalent problems are high rates of diabetes, polio, and blindness. Tuberculosis is also a problem, and maternity and infant mortality rates are unacceptably high. There have been a few cases of leprosy reported each year, and malaria exists. In both cases the trend has been significantly downward in recent years. Recurrent outbreaks of cholera are swiftly checked, and some believe that cholera and malaria can be eradicated in 10 years. Finally, both traffic and work accidents are numerous.[9]

The status of medical services and its accessibility, as viewed by the Saudis themselves, depends on who is asked and where they live. Differences exist in staff and equipment standards between the specialist hospitals and the public hospitals run by the MOH, which are normally attended by the average citizen. King Faisal Specialist Hospital—where operating a bed costs $300,000 annually—is probably the best hospital in the Kingdom, with the best and most experienced staff and comprehensive medical equipment and systems. This institution admits all patients and works through regional medical committees, which refer serious cases. Nevertheless, there has been a widespread view that those who are not rich do not have the means to receive the best medical care the Kingdom has to offer.

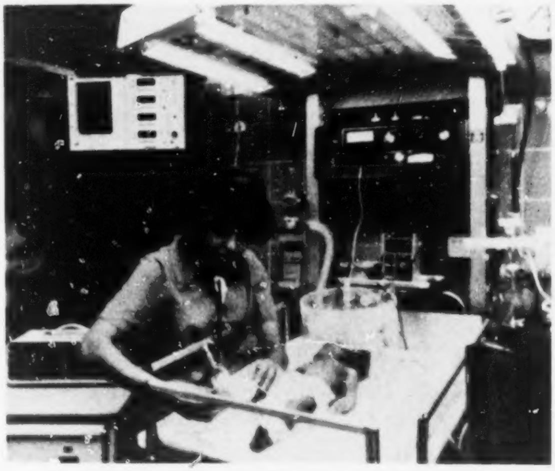

Photo credit: Saudi Arabian Ministry of Commerce

Neonatal care in Saudi Arabia

Besides poorer Saudis, three minority groups have had, and in some cases still have, problems obtaining adequate health care. The large group of foreign workers are sometimes admitted to the older, lower-standard hospitals or clinics unless special arrangements can be made. The more than 1 million pilgrims who flood into Mecca each year have received poor care in Saudi Arabia in years past, but this situation has been improving. The Bedouins are gradually being drawn into the health systems of MODA and the National Guard via their sons who join the armed forces.

The MOH is well aware of the availability of hospital beds in Riyadh and Jeddah and the lack of proper health care in other parts of the country. Its plans, which are slowly being implemented, include the establishment of regional hospitals that will function as centers of a widespread network of local health centers and clinics. Some of the newly constructed, highly sophisticated MOH hospitals are situated in areas previously least-served. If the manpower situation can be improved, it is expected that many of the more obvious regional and population differences in medical care will be greatly reduced in the next 10 to 15 years. The Ministry of Health has developed an ambitious plan to build 36 new hospitals (with

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[8] This statement is based on interviews conducted for OTA in 1983 with U.S. and British physicians in Saudi Arabia, and on WHO data (1978). In interviews with representatives from the major U.S. health care management firms, it was claimed that the major medical need in Saudi Arabia is preventive care and improvement of public health, including social and living conditions, education, and nutrition.

[9] The numerous work accidents (no statistics available) are probably due to a combination of factors such as the high rate and speed of construction, fines if the work is not ready on time, and problems with on-the-job safety.

7,000 beds) and to add 2,000 beds in existing hospitals.

Kuwait

Kuwait probably has the best medical services of any of the countries under review. Swift socioeconomic development has brought improved health status and an expanding health care system. Kuwait's medical facilities have expanded from 100 hospital beds in 1949 to 6,400 in 1982. There are, however, some health problems related to the growing population, urbanization, the changing patterns of disease, overuse of health services, and dependence on an expatriate health work force.

The Ministry of Public Health is responsible for the overall control of all health services in Kuwait, including both the public and private sector. There is little delegation of authority to the individual public sector hospitals as all planning, budgeting, administration, organization of domestic and technical services, staffing, and procurement remain under ministry control. Ministerial authority over the private hospitals is less direct, being exercised only through its licensing authority and supervision of standards. In 1982, of the 6,400 hospital beds in Kuwait, about 5,000 were in Ministry of Public Health hospitals.

All medical treatment, including prescribed medicines, dental treatment, and provision of eyeglasses, is free of charge in the public sector clinics, polyclinics, and hospitals, which serve all residents regardless of nationality. The basis of the Kuwaiti health service is a primary care network of clinics and polyclinics. These, in turn, are subordinate to preventive health centers. Everyone is required to register with the nearest clinic, which is usually staffed by both male and female general practitioners and sometimes a pediatrician. The clinics usually have a small pharmacy and are open 8 hours a day. Some clinics, usually attached to one of the hospitals, specialize in maternity, dental, or child care. For more specialized treatment, patients are referred to one of these or to one of the collective health centers.

In spite of the ambitious health care program, pressures continue on the public sector hospitals and clinics. Many wealthy Kuwaitis still seek consultations and treatment in Europe. Even less wealthy Kuwaitis often prefer private sector facilities, because of the delays and problems in liaison between public hospitals and out-patient clinics.

The present population of 1.4 million has more than doubled in the last 10 years and is expected to double again by 2000. This rapid population expansion has overwhelmed the health care system, despite the program for 3,000 new beds initiated in the second half of the 1970's. Each person averages five to six visits to a clinic each year. Many of the visits are for social rather than medical purposes, but it is nevertheless policy that each patient must be seen by a doctor. As a result, each of the 251 doctors, supported by 582 nursing staff in the primary care network, sometimes sees more than 100 patients per day.[10]

Kuwait has a falling death rate and a decrease in new cases of tuberculosis. Tuberculosis used to be one of the major problems in Kuwait, but a compulsory screening program of all school children and newcomers to Kuwait and wide-reaching health education have significantly reduced the incidence of tuberculosis. The major causes of death for adults in Kuwait are traffic accidents, heart disease, and cancer—all associated more with the industrialized world than with developing countries.

Kuwait is already heavily dependent on expatriate skills and administrative ability throughout its health service and will remain so for many years to come. When the current hospital building program is complete, it is estimated that Kuwait will have to recruit 15,000 extra staff. Kuwaiti doctors enjoy a privileged status and therefore tend to remain in Kuwait. Expatriate doctors, particularly those from Western countries, often find the social structure and living conditions difficult to adjust to.[11] Kuwait's shortage of doctors has also been accentuated by a tendency of expatriate doctors, both Arab and non-Arab, to go to Kuwait's neighbors, especially Saudi Arabia and the Emirates, where salaries and status are higher.

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[10] *World Medical Markets* (West Sussex, U.K.: Kuwait, 1983).

[11] Ibid., p. 5.

Egypt

Egypt has a fairly well-developed health care system, but it also faces serious problems. Free medical care is provided through the Ministry of Health's network of hospitals, district health centers, and rural health units. A private health care sector also exists, with some outstanding facilities for those who can afford their services. Thus, the Egyptian health care sector is now moving along two distinct tracks. One is for the basically healthy, wage-based employee, who lives in an urban area and pays for services through socially financed health insurance or fee-for-service payments. The other track is for the low-income, unskilled worker in rural and suburban areas, who relies on traditional medicine, pharmacists, or the Ministry of Health system for services.[12]

The Ministry of Health (MOH), which is charged with the promotion and protection of the health of the entire population, is underfinanced and overextended. Its current infrastructure does not permit it to conduct efficient operations to serve the group that is least able to pay for health services of any kind. Nevertheless, in attempting to compete with the emergent public/private sector, it has opted for additional investments in high-cost curative care services (hospitals and emergency medical services) that offer visibility and professional satisfaction to an expanding group of physicians.[13]

The health portion of the national budget has decreased substantially in recent years. Egypt spent approximately 5.6 percent of its total budget on health care in 1976. By 1979 the figure fell to 4.0 percent, and the estimate for 1980-81 was 3.6 percent. This budget decrease must be viewed in light of the fact that the personnel side of that account is increasing at an average rate of 11.4 percent per year. Thus, salaries consume an ever-increasing share of a shrinking resource base.

In spite of its fairly well-developed health care system and relative abundance of doctors, Egypt has several problems related to sanitary facilities, water supply, housing, and population growth. Family planning programs have not prevented a rise in the Egyptian birth rate in the 1970's; poverty and inadequate sanitary facilities result in a large number of pre-school deaths from diarrheal disease; there is a high incidence of bilharziasis, respiratory diseases, and other enteric diseases. Perhaps two-fifths of the country's 43 million people now harbor the bilharzia parasites—a public health burden of staggering proportions.

Egypt's nine state medical schools graduate about 3,500 new physicians each year. With the present structure and scope of the governmental and private sector health system, this number more than fulfills the national demand for doctors. There is, however, a drain on the supply of doctors due to a substantial emigration to other Arab states, Africa, the United States and the United Kingdom. New physicians emigrate because of their dissatisfaction with low salaries and limited opportunities for postgraduate work. According to the view of the Medical Union, Egypt produces but does not have an overabundance of doctors. Egypt is also chronically short of well-trained nurses and other essential backup personnel.

Another problem is the concentration of qualified physicians in the urban areas and the corresponding shortage in the more remote parts of the country. Medical graduates are expected to spend their first 4 years of obligatory service to the MOH in rural health services, but the majority of doctors leave in less than half that time. In order to change this imbalance in health services, a community medicine element has been introduced into all medical courses at the state-run teaching hospitals, and greater emphasis has been placed on practical skills than on acquisition of theoretical skills. With assistance from the U.S. Agency for International Development (AID), the curriculum has been upgraded at the medical college of Suez Canal University to emphasize a community-oriented approach to medicine.

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[12] U.S. Agency for International Development, "A Report on Health Development in the Arab Republic of Egypt: A Sector in Transition," May-June, 1982.

[13] Ibid.

Algeria

Although impressive gains were made in the development of Algeria's heavy industry under past development plans, conditions in housing, health, and other social sectors tended to deteriorate. Rapid population growth and heavy rural-urban migration expanded needs for social services, but the low level of investments in social sector infrastructure failed to keep pace with the expansion of needs. The current Algerian plan, 1980-84, seeks to redress the imbalance of past development plans by reorienting investment toward social sectors, particularly medical care.

Three governmental ministries have the main responsibility for health care services in Algeria. The most important of these is the Ministry of Health (MSP, Ministére de la Santé Publique), responsible for some 85 percent of all health care establishments in the country. The other two are the Ministry of Defense and the Ministry of Higher Education responsible for the planned university medical centers but not for the existing ones.

Several other organizations are also involved in health care activities. The Social Security Organization is responsible for mother and child care, for care of the handicapped, and for establishing sociomedical centers in residential areas. The National Health Institute is responsible for the training of health personnel other than physicians. In addition to these, state-owned corporations (practically all medium-sized and large corporations are state-owned) often have their own health care. The largest corporations are Sonatrach and SNS, dealing in petroleum and steel, respectively. These corporations are responsible to various ministries, often the Ministries of Heavy and Light Industry. The private sector is insignificant and consists mainly of private practitioners working half-time in their own practice and the rest of the time in MSP hospitals.

While resident population increased by 32 percent between 1969 and 1978, the number of hospital beds increased by only 12 percent over the same period. The increasing density of population per health facility in Algeria during the last decade reflects the low level of investments in health infrastructure during the period. This slow growth of health infrastructure has led to a serious shortage and crowding of health facilities. The current health plan aims to improve the overall availability and regional distribution of health facilities through an ambitious program of health sector investment.

The most striking increase in programmed health facilities is planned for health centers, which are seen as the basic outlet for provision of primary health care in the country and as a "filter" to control the use of more specialized health facilities, such as hospitals, polyclinics, and maternity centers. Thirty-nine new general hospitals are planned, and seven new specialized hospitals for psychiatric care, pediatric care, burn care, cancer treatment, and treatment of cardiovascular disorders are scheduled to be completed in 1984.

Better health requires environmental improvements affecting water supply, sanitation, and nutrition. Evidence from other settings has shown that improvements in these areas often do more to promote health by reducing exposure and susceptibility to disease than do health efforts in treating illness and disease. One area where potential progress is possible in Algeria is in improved supplies of drinking water for newly weaned children. An experimental program of rehydration therapy has recently been undertaken by the MSP to determine the most efficient approach for reducing the incidence of infant death from diarrhea. An important part of this program is the provision of information to mothers about the necessity of maintaining fluid intake for children. Such efforts may lead to important benefits in reducing deaths from diarrhea, but further improvements will depend on improved water supplies and sanitation to control the transmission of diarrheal organisms.

One of the specific areas of health intervention which is clearly given priority in the current Algerian health plan is the government's newly adopted population policy, which calls for lowering the overall rate of population growth through a vigorously expanded birth-spacing program. Further increases in female school enrollments and female employment are also expected to decrease the rate of population growth.

Iraq

Since 1978, Iraq's rulers have become much more concerned about the welfare sector. With the rise to power of Saddam Hussein in 1980 came stress on mobilizing the masses, and a clear commitment by the government to expand the scale and scope of the welfare state.

All hospitals in Iraq with the exception of military facilities are managed by the Ministry of Health (MOH). The MOH is divided into five departments; the country is divided administratively into 18 governorates, each with a chief medical officer responsible for all health services and institutions in the governorate. In 1980, there were 200 hospitals with 30,000 beds.

Health conditions in Iraq gradually improved over the last few decades as hospital services were introduced. In 1978, the government initiated a substantial hospital and health care development program, but this was scaled down considerably in recent years.

Medical personnel, particularly nursing staff, remain in short supply, despite the expansion of medical schools, and support services are inadequate. A rural health program, begun in 1963 to assist in the elimination of chronic disease, including malaria, trachoma, and bilharziasis, has met with mixed success. Parallel construction of new and improved rural water supplies and the spread of education has helped to bring better standards to most, although not all, regions.

In 1981, a foreign consultant was commissioned to study long-term health care development for the MOH. Because of the war, this work has been postponed, as were most of the projects in Iraq that are not considered essential. The president of the State Organization of Buildings said in 1981 that the organization was engaged in carrying out hospital development projects valued at $800 million. The largest projects were the expansion of a huge Medical City, five general hospitals, and six pediatric and maternity hospitals. Early in 1982 ongoing health care projects included some 25 MOH projects and 15 military hospitals, all in different stages of development. Several of these projects have been terminated, however, owing to the changed wartime priorities.

In 1981, Iraq ranked as one of the largest Middle East importers of medical products, comparable with if not equal to Saudi Arabia. The continuing war with Iran and the reduction in oil exports from 3.3 million barrels per day (b/d) in 1980 to 0.7 million b/d in early 1983 sharply reduced oil revenues. With war expenditures escalating, Iraq has had to slow down the pace of its vast economic development plans and concentrate its financial and human resources instead on support of the war. Health care now ranks behind the war, war-related projects, energy, and industry in priority. The military, however, whose health care expenditure comes out of its own budget, continues to spend on an increasing scale, owing to war casualties.

Iran

Little authoritative information is available concerning the present state of health care and health care facilities in Iran. In prerevolutionary Iran, however, the system of health care delivery was relatively extensive. The government health care budget in 1978 totaled $950 million, over half of which was administered by the Ministry of Health (MOH). A large majority of the 50,000 hospital beds were operated by government agencies or universities. Thirty-eight hospitals were affiliated with universities throughout Iran, seven of which provided training for students at medical colleges. The 125 private hospitals in Iran were mostly small but provided better treatment than the government facilities. In 1978, there were about 3,000 clinics, run mainly by the government through the MOH or special health corps.

At the time of the revolution, the government had drawn up a much-publicized master health care plan designed to provide the country with 15 regional hospitals, 130 smaller hospitals, some 2,000 new health clinics, and 10 other medical projects, including extensions of 6 existing specialist hospitals. A few of these projects were under construction, and several were in an advanced design stage in 1979.

There is no doubt that Iran had made significant progress in its medical services up until 1978. Several problem areas remained, however, particularly with manpower allocation. People outside of Teheran, and especially the more remote populations, received treatment significantly poorer than that given residents of the capital. Some 45 percent of the hospital beds and about 60 percent of the doctors were located in Teheran, which had only an estimated 10 percent of the total population. Imports of physicians did improve health care standards in the provincial areas, but the growth rate in the number of Iranian doctors per hospital decreased in the latter part of the 1970's when the number of foreign-trained, homecoming Iranian physicians could not match the number of doctors leaving the country. It was estimated that some 60 percent of Iranian medical staff training abroad would not return home, and that about 15,000 Iranian doctors were living abroad in 1978.

The Iranian revolution apparently led to drastic changes in health care and in medical education.[14] There is reason to believe that the new government has not yet been able to take active measures in the health care sector. Iranian revolutionary leaders emphasized the need to improve health care in remote areas, and health ministers called for importing foreign physicians to serve the villages. The new government initially closed down all medical schools, however, and projects for auxiliary health worker training reportedly ended. Female students were not encouraged to go on with their studies. A large number of physicians were expelled from the university hospitals, and many Teheran University Medical School faculty members were dismissed or forced to leave the country. During the reign of the Shah, 2 years of health corps work was mandatory for all medical graduates; currently 5-year compulsory service in the rural areas is recommended. As a result of deteriorating capabilities in the public health departments, vaccinations reportedly have declined and epidemics of infectious diseases have risen. The only school of public health, in Teheran, was closed.

Regional Efforts

Attempts at regional cooperation among Middle Eastern countries in health care, medical products manufacturing, or disease eradication have been largely unsuccessful, partly because, even within countries, conflicting goals exist among the different ministries and organizations responsible for health care. Other reasons include: 1) the relatively recent stress on improved health, 2) the diversity of health problems and financial and manpower resources available to deal with them, and 3) large political differences separating countries in the region. Attempts have been made to produce medical disposables (syringes, gauze, etc.) and pharmaceuticals regionally, since the market in just one country would often not justify establishment of production facilities. Kuwait is establishing a syringe factory, and Egypt produces several medical products (pharmaceuticals, in particular). Egypt also has plans for production of medical furniture. Extensive plans for regional distribution are, however, still far in the future.

The Arabian Gulf University's medical school in Bahrain is today the only regional medical cooperation project initiated and administered by the countries themselves. It is being cofinanced by Bahrain, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates. The school, which will form an extension to the Salmaniya Hospital Complex in Manama, is scheduled for completion in 1984, enrolling 50 students from the participating countries, with a majority from Saudi Arabia, Kuwait, and Iraq.

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[14] The information on present Iranian health care is based on interviews conducted for OTA during 1983.

Although highly unstructured, medical training and physician emigration probably most closely approximate "regional cooperation." As often occurs in scientific endeavors in the civilian sector, medical training and information is freely exchanged among the medical communities of the Middle East. Most hospitals in the Middle East have a staff composed of diverse nationalities with a large regional contingent. Transfer of medical skills from country to country also occurs through emigration for financial or political reasons, although sometimes to the detriment of the training country, which has spent years and substantial public resources on their training.

Efforts in the Middle East by outside organizations such as the World Health Organization (WHO) and Project HOPE have met with substantial success, particularly in control of infectious diseases and training of preventive care personnel. Both organizations emphasize effective training and technology transfer in the medical sector.

WHO sponsors medical projects in the region through the Eastern Mediterranean Regional Office (EMRO) in Alexandria, Egypt, which covers all countries under study except Algeria. It has initiated and carried out a substantial number of health care projects in the region despite a background of repeated changes and frequent realignment of policies by the member countries. A few of the most ambitious projects are:

1. *Maintenance and repair of medical equipment.* WHO is taking a multiphase approach, which includes services of consultant engineers and activities in the Regional Training Center for Maintenance and Repair of Medical Equipment in Cyprus. This involves technician training, including specialized courses on medical equipment, and training of biomedical engineers.
2. *Expanded program of immunization.* All member countries collaborate with EMRO —mainly in interregional training activities, but also in implementation, evaluation, and program reviews.
3. *Promotion of environmental health.* This includes establishment of sanitary engineering laboratories, assignment of sanitary engineers in Iraq, Egypt, and the UAE, and establishment of a Regional Center for Environmental Health Activities. This center will assist in developing training capabilities, will develop a re-

Photo credit: Aramco World Magazine

Preventive medicine has made important contributions to public health in the Eastern Province of Saudi Arabia gional information and reference center for environmental health, and will provide a means for technology transfer within the region.

U.S. efforts in foreign assistance in the countries under study have centered on AID programs in Egypt, rather than on regional efforts in the health care field. Typical programs affecting medical services and general health have focused on agricultural production, hospital administration, health service delivery systems, nutrition survey techniques, public administration, and foreign investment promotion and negotiation procedures. AID programs are discussed in more detail below.

PERSPECTIVES OF RECIPIENT COUNTRIES AND FIRMS

PLANS FOR DEVELOPMENT OF MEDICAL SERVICES

In order to assess the perspectives of the recipient countries with regard to utilization of medical technologies, a brief review of government health policy is presented in this section. Great diversity in emphasis is noted among the countries under study. For example, Saudi Arabia and Kuwait now have well-developed medical infrastructures and are thus redirecting their efforts toward preventive health care and indigenous manpower training. At the other extreme, Iran and Iraq, torn by war and internal strife, have had to postpone many of their plans for the medical services sector. Future developments in their health sectors will depend on the duration and severity of the war.

Saudi Arabia

Vast oil wealth combined with a strong commitment to provide free health care services to Saudi Arabia's inhabitants has sustained a striking growth in medical services in the last 10 years. Table 73 shows the budget of the MOH as compared to the general budget of Saudi Arabia from 1970 to 1981. In this time period, the MOH budget increased almost fortyfold, staying at a relatively constant percentage of about 2.5 percent of the total Saudi budget. Much of the increased expenditure went to infrastructure construction, rather than to programs designed to upgrade the quality and distribution of health care. Hospitals using very sophisticated technology were built in the public and private sectors.

In the past the concentration has been on curative medical services and on secondary care through hospitals rather than on preventive medicine and primary care. This was seen as the most appropriate way to provide for immediate treatment of disease and has been reflected in budgetary allocations. Even today the legacy of the ambitious hospital building program promoted in the mid and late 1970's commands the major share of the health budget, with a further 36 MOH hospitals providing 7,500 additional beds scheduled for completion in the 1983-90 period.

The third national development plan, however, attaches a high priority to the restructuring of health care. A fully integrated and comprehensive system is planned for every region, with emphasis on preventive health measures that include vaccination programs, environmental health, early screening, and mother and child care programs. This goal will be achieved by expanding and reorganizing the system of dispensaries and health centers to meet local population requirements. More than 300 health centers are to be established.

Through the establishment of a National Health Council, the government hopes to guide the development and improvement of all health services. One goal is to delineate the responsibility between the government health

Table 73.—Budget of the Ministry of Health as Proportion of Total Budget, Saudi Arabia, 1970/71-1981/82

Years	General Budget (millions S.R.)	Ministry of Health Budget (millions S.R.)	Percentage
1970/71	6,380	117	2.8
1971/72	1,078	279	2.6
1972/73	13,200	420	3.2
1973/74	22,810	582	2.5
1974/75	45,743	1,162	2.5
1975/76	110,935	3,197	2.9
1976/77	131,296	2,972	2.3
1977/78	134,253	3,384	2.5
1978/79	144,558	4,040	2.8
1979/80	185,820	4,177	2.2
1980/81	245,000	5,656	2.3
1981/82	298,000	6,831	2.3

NOTE: 3.4 Saudi riyal (S.R.) = $1.00

SOURCES: Ministry of Health, Saudi Arabia, Statistics Department, *Statistical Review*, 1391-1300 A.H. (1971-80), pp. 162-164; Business International, *Middle East Market Opportunities*, May 1982, pp. 14, 15.

agencies and the private sector and coordinate their activities. Whether the council will be able to reign over the independent MOH, the powerful military health organization, and the private sector remains to be seen.

Training is a central feature of Saudi health care plans.[15] Present government plans envisage a 90 percent increase in the number of physicians over the next 5 years. According to the previous Health Minister, Saudi doctors will comprise half of all physicians by 1995. Outside observers judge this to be overly optimistic. While the large increase in student numbers is consistent with that objective, expansion will be limited by high dropout rates and some migration to the West of newly qualified doctors seeking higher training.

A fourth medical school was scheduled to open in 1983, with a philosophy based on increased community orientation and a balanced exposure to clinical medicine and health ecology. Five nursing training institutes are also planned, although the number of graduates in the years up to 1990 is not expected to rapidly increase the share of Saudi nurses. Large-scale training of technicians and administrators is not being planned. It is difficult to anticipate supply and demand for medical manpower, but estimates have been made that during the next decade the government—without counting the other health care agencies—could need an additional 20,000 medical, paramedical, and ancillary staff.

Kuwait

With a small, geographically concentrated population and a fairly good medical facilities infrastructure in place, Kuwait did not pursue as vigorous a hospital building program as Saudi Arabia. Government health expenditures have nevertheless grown recently. Health ministry expenditures grew 11.5 percent between the two last budgets, from 171.7 to 191.5 million Kuwaiti dinars, while the ministeries' budgets grew by 5.3 percent.[16]

In Kuwait's National Health Plan of 1981, emphasis is placed on development of manpower as well as facilities, medical education and disease prevention. Kuwait plans to build three new regional hospitals, extend four, and provide 40 district health centers, 22 of which will be new facilities and the rest replacements. Health promotion measures span the fields of health education, mental health measures, social security, improved housing, and sanitary waste disposal. Immunization, maternal and child health, and control of communicable diseases are stressed under disease prevention.

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[15] Ministry of Planning, Saudi Arabia, Third Development Plan, 1980-85.

[16] National Bank of Kuwait, Vol. 1, No. 2, October 1982. (1 Kuwaiti dinar = $3.40)

Plans emphasize early diagnosis and prompt treatment of disease through health registration, screening, and community-based medical care.

Manpower is a major problem since in 1980 over 75 percent of Kuwait's medical personnel were expatriate. Total medical staff are expected to increase from 26,000 in 1980 to 41,000 in 1990 to 58,000 in 2000 (at least 50 percent of whom, it is hoped, will be Kuwaiti). Key elements in Kuwait's manpower strategies include training programs for senior and mid-level administrators, which provide incentives for Kuwaitis in health careers through community education, salary and other incentives, and career development. Community health-oriented teams consisting of a general practitioner, nurse, and social worker are planned. In addition, measures have been introduced to promote postgraduate training in public health, and to increase medical school annual enrollment from 50 to 150 students as quickly as possible. The number of Kuwaiti nurses is to be expanded by enhancing the prestige of nursing and by providing exposure to a nursing career through educational programs in schools and on television.[17]

Egypt

Reducing the rate of population growth in Egypt is an important goal of the Egyptian government. In a 1982 speech, President Mubarak called on the Egyptian people for "hard work to reach a more balanced relation between the number of population and the volume of gross national production," and asked the nation to "attentively consider the rate of population growth."

The Minister of Health, Dr. Zaki, has outlined the general strategy for the health sector. Health insurance is considered the cornerstone of health care, and the number of beneficiaries should be increased each year to provide complete coverage of the population by 1990. Emergency medical care services and first aid services are to be developed and expanded. The public sector will ensure a large portion of the drug supply. In the meantime the private sector should be encouraged to contribute toward completing the ministry's plan for providing drugs to the population at reasonable costs.[18] In addition, the government hopes to improve the efficiency of preventive health services, with emphasis on given to immunization, environmental sanitation, food control, and early detection and treatment of endemic diseases (particularly bilharziasis). Health manpower resources will be upgraded through education and training for medical and paramedical personnel. The pressing problem of improving water and sanitation will be seriously addressed.

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[17] The manpower plans may be difficult to achieve. The practical plans for implementation since the 1981 proposals were made, however, include:

1. The Medical School will increase enrollment to between 150-200.
2. The jointly founded Gulf University in Bahrain is expected to meet some of the manpower demand.
3. The policy of overseas training—including postgraduate training—will be continued.
4. Increased and improved employment incentives are planned.
5. Recruitment is being tried through contracts with foreign medical institutions, which may produce better results than through the individual contract approach used in the past.
6. Health accords will be made with countries like Great Britain, Pakistan, Sweden, and Denmark, mostly involving exchange of expertise and training of doctors.
7. The Nursing Institute will be expanded.
8. A 5-year program has started in schools and through television and other media to convince Kuwaiti families that nursing is a respectable profession.
9. Productivity is given special attention in ongoing hospitals.

See Ministry of Public Health, Kuwait, Kuwait Health Plan (1981).

[18] Key ingredients of the Egyptain drug plan are:

1. a commitment to provide drugs to the population at reasonable costs;
2. continued subsidies of imported products not produced in the country;
3. a prescription system that will continue to allow people to buy whatever drugs they like from the pharmacist;
4. increased protection of locally made drugs against foreign competition;
5. encouragement of joint ventures between foreign and local companies to increase technology transfer; and
6. improved health education in order to reduce misuse of drugs.

Middle East Health Magazine, Great Britain, March 1982; American Public Health Association: "A Report on Health Development in the ARE (Arab Republic of Egypt)," 1982.

Algeria

The policy guidelines for the 5 years covered by the latest plan include emphasis on investment in health care infrastructure, featuring an increase in hospital beds from 45,000 in 1979 to 64,000 in 1984, 1,000 new health centers and dispensaries, and over 100 maternity centers. However, in the past, plan targets have not been achieved: only 19 percent of the number of hospitals and about 30 percent of the health centers planned under the previous plan were actually constructed.[19] The expansion of training of health manpower of all kinds remains a major priority. In addition, environmental health, water supply, sanitation, nutrition and birth control are important areas.

Several measures are included which are aimed at lowering the infant mortality rate: 1) from 1979 to 1984 the number of maternity centers will be increased from 58 to 172, 2) two new hospitals for pediatric care will be established, 3) sufficient maternity facilities will be established to assure that more than 50 percent of deliveries are assisted in health facilities by 1987 (in 1982 only 40 percent of the births—10 percent in rural areas—occurred in a medical facility), and 4) water supplies and sanitation will be improved to control the transmission of diarrheal organisms, and programs of rehydration therapy will be instituted.

Iraq

In the early 1980's Iraq began to study long-term health care needs. The government prepared a long-term health plan for the 1980-95 period, with the ultimate goal being health care for all by the year 2000. This plan embraced the primary health care (PHC) approach. It reflected a change from the traditional curative approach of the health services to one based on preventive public health. This was to include strengthening of mother and child health care, including the promotion of breast-feeding, reinforcing environmental health activities, and an expanded program of immunization and tuberculosis control. The plan called for local production of essential drugs and quality control of imported pharmaceutical products.[20] Also included were improving existing health care facilities with a special emphasis on basic health care provided in medical centers and clinics in both urban and rural areas and an increase in the number of regional multidisciplinary hospitals. Tertiary care in new specialized hospitals in the major cities was also to be provided with the focus of investment on the Medical City in Baghdad, the largest medical complex in the Middle East.[21] However, due to the war with Iran, these plans have been postponed.

Iran

Iran's government has made few statements to clarify plans for health sector development in the past 5 years. Before 1979, the fifth development plan emphasized the following: 1) health services, with a special focus on control of infectious diseases through immunization, mother and child health and environmental sanitation; 2) birth control, (in 1978 net population growth was 3.1 percent); 3) health facilities, with a target of increasing the ratio of hospital beds to 10,000 people from 15 (in

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[19] World Bank, "The Five-Year Development Plan 1980-84," June 1982.

[20] Quality control of imported pharmaceutical products is a problem in Iraq, as well as in other Middle Eastern countries. Imports of pharmaceuticals to Iraq come from 400 foreign companies, with few restrictions. Iraq's limited capacity to regulate drug imports and its badly organized distribution system make it difficult to prove accusations that low-quality pharmaceuticals have been directed to this market.

Imports of illegal drugs do take place in these countries. In 1982, Kuwait drafted stiff laws aimed at ending drug trafficking and abuse. Trading in drugs was restricted, and only qualified doctors were allowed to prescribe drugs.

See: U.S. Department of Health, Education and Welfare "Iraq Health Sector Plans," 1977; *Middle East Health Magazine*, West Sussex, Great Britain, May 1982.

[21] In 1979, the Medical City consisted of an 800-bed teaching and general hospital. In 1980 a contract was signed with South Korean contractor Hyundai to build phase 2 over a period of 4 years. This was to include a 650-bed surgical hospital, a 250-bed private nursing home, a 200-bed children's hospital, a conference center, and administration and service buildings. This second stage of development has fallen well behind schedule. Also, the existing complex is said to be serving fewer patients than anticipated because of the shortage of medical staff. See World Medical Markets Iraq, Great Britain, October 1982; *Middle East Health Magazine*, Great Britain, May 1982; U.S. Department of Health, Education and Welfare, "Iraq Health Sector Plans," 1977.

1978) to 20 (in 1984); 4) rural medical and health services, with a major objective being to add 600 new medical and health centers with responsibility for outpatient treatment, immunization, birth control, and nutrition information at the village level; 5) training, with the establishment of 2 new medical faculties, 3 schools for auxiliary health workers, and 26 nursing schools; and 6) research, with emphasis on fields related to birth control, environmental sanitation, development and production of vaccines, and nutritional problems.

ASSESSMENT OF THE ABSORPTION OF MEDICAL TECHNOLOGIES

In order to evaluate the use of medical facilities and technologies in the Middle East, this section deals with the following medical services categories: 1) health care planning, 2) use of medical equipment and systems, 3) servicing and maintenance, 4) local production of medical equipment and supplies, 5) hospital design and construction, 6) hospital management, and 7) training of local personnel. Key problems are identified in training of local personnel and servicing and maintenance of equipment.

Health Care Planning

Technology transfer occurs through foreign assistance in medical education and health planning. As teachers and curricula from the United States and the United Kingdom have been incorporated into Saudi Arabia's medical education, and as Saudi students have pursued postgraduate studies abroad, the professional skills of Saudi medical personnel have been improved and preferences for medical systems and equipment developed. Foreign advisors together with a group within the Kingdom, have reappraised Saudi achievements in the health care sector. The result is shown in the priorities of the current 5-year plan, which represents a departure from earlier preoccupation with hospitals and curative-based services. Such services are said to have done relatively little to redress the underlying health problems, especially at the local level. Instead, the importance of preventive medicine, primary care, environmental health, and coordinated health planning is recognized, and they are becoming components of the national health policy of Saudi Arabia.

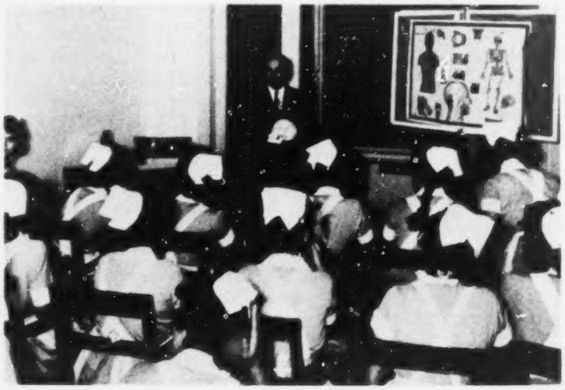

Photo credit: Middle East Economic Digest

Nursing training in Iran

Use of Medical Equipment and Systems

Simple equipment can be rendered useless when local needs and customs are not considered in technology transfer. For example, in a prerevolutionary Iranian health project, elaborate fiberglass chairs were purchased for a mother and child center in a rural area. Assuming that the chairs were put there for decorative purposes, the mothers refused to use them, preferring to sit on the floor with their children as they were accustomed to doing. In Iraq, scissors imported from the West for use in cutting plasters were found to be useless because the plaster casts used in Iraqi hospitals were harder than those used in Europe. In both cases, the purchase decision was made by people who did not have the necessary knowledge of local conditions.

A member of the Faculty of Engineering at Cairo University has furnished some detailed examples of successful and less successful transfers of medical equipment and systems in Egypt.[22] An example of a successful transfer to Egypt is the Diagnostic Ultrasound Center, established at Cairo University Hospital with the assistance of the U.S. National Science Foundation and the Alliance for Engineering in Medicine and Biology. This project, operating since 1976, was established as a nucleus for the development and diffusion of such services. The development of ultrasound diagnostic services was a high medical priority, but the technology was complex and "transferability," in terms of local ability to maintain the systems in operation, was difficult. Many factors contributed to the success of this transfer:

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[22] Ahmad Gaber, "Appropriate Health Care Technology Transfer to Developing Countries," Project HOPE Conference, Millwood, Va., April 1982.

1. Excellent cooperation between "donors" and the "receiver."
2. Sound planning at all stages—e.g., equipment specification, procurement, relations with manufacturers, staff training, and supporting services.
3. Adequate training of sufficient numbers of all types of staff: medical, operating, and maintenance.
4. Good routine management, with regular coordinating meetings between all involved groups, progress evaluation, and educational workshops.
5. Adequate budgetary allocations, which covered staff incentives and technical support needs.
6. Ample provision of maintenance facilities and commitment to this work.

An example of a relatively unsuccessful transfer of medical technology to Egypt concerns Neonatal Intensive Care Centers.[23] These were established in eight Egyptian University hospitals with assistance from the U.S. Department of Health, Education, and Welfare. The three units opened so far have experienced great difficulties in various stages of their development. In one hospital none of the more than 20 incubators functioned satisfactorily. Reasons cited were:

1. Poor initial specification of equipment to be procured. Many incubators were supplied with the wrong main voltage characteristics.
2. Faulty installation and commissioning by the manufacturers' agents. In many cases the operating temperatures of the incubators could not be set above 90° F.
3. Inadequate provisions for preventive maintenance or repairs. No available in-house staff had the technical competence for this job, and there was inadequate distribution of spare parts ordered with the initial purchase. No technical service manuals were provided.
4. Lack of any engineering "voice" in the management of the technology. No arrangements were made for technical advice or support.
5. Inadequate training of nurses. Only the senior staff had received useful training, and they were not involved in the day-to-day control and operation of equipment.
6. Poor relationships between hospitals, manufacturers, and their agents.

Effective use of medical equipment and systems requires sound planning and initial specification, adequate training, and good day-to-day management and maintenance.

Servicing and Maintenance

The problem most frequently discussed in connection with transfer of medical equipment and systems is not the question of appropriateness of the technology, but that of servicing and maintenance. Servicing and maintenance are considered crucial in the analysis of technology absorption, since, 20 to 60 percent of existing medical equipment in the Middle East may be out of order at any given time.[24] Thus, successful future transfers of medical technology will require substantial improvements in this area. Some key aspects of this problem and examples of ways of dealing with it are discussed below.

EMRO states that the availability of diagnostic and therapeutic services is substantially lower than might be indicated from trade and statistical sources, owing to the large quantity of equipment which has not been properly serviced or repaired. With the rapid expansion of health services in this area in recent years, there has been a large accumulation of equipment. This equipment, purchased from widely different sources and with a wide range of sophistication and complexity, must be continuously repaired and maintained if it is to be used effectively. Generally speaking, tremendous expenditures have been made for purchase of equipment and supplies, while comparatively little budgeted for effective maintenance.[25] As a result, medical equipment, even with minimum damage, may be out of service for extended periods, or even permanently.

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[23] Ibid.

[24] World Health Organization, Eastern Mediterranean Region Office, "Biennial Report of the Director, 1979-1981," Alexandria, p. xxiv. Unfortunately, this report gives no figures for types or categories of equipment most prone to difficulties.

WHO believes that the major reasons for these problems are: 1) lack of understanding of the need to plan and budget for maintenance and repair, 2) inadequate administrative mechanisms to ensure prompt and regular delivery of spare parts and expendable supplies, 3) failure of maintenance and repair services to reach peripheral areas, and 4) competition between the various suppliers and agencies sometimes selling equipment without guarantee of spares or service. Until recently, Saudi Arabian buyers reportedly rejected maintenance contracts. Increasing awareness of the maintenance problem is also apparent in Iraq and Algeria, where government decrees insist that a training component be included in contracts signed with foreign companies, and also that suppliers be held responsible for service and spare parts for up to 3 years after delivery.

Most foreign suppliers of medical equipment are prepared to provide service and maintenance packages and training of local technical personnel, when compensation for these efforts is seen as adequate. One approach is to offer a service and training package in the equipment purchase price or as a related contractual arrangement. The hospital equipment company Hospitalia International warrants all equipment for 12 months, making service an important component. The products of Warner-Lambert Company (medical diagnostics) also carry warranties; the company does not introduce a product unless it has established mechanisms for full service.

Two examples of training local manpower in operation, maintenance, and service are noted. One is the Regional Training Centre for Maintenance and Repair of Medical Equipment in Cyprus (funded by WHO), which has already been briefly described under regional medical cooperation projects. The other is the Department of Medical Equipment at Abbassia, Cairo, established by the Ministry of Health with assistance from the Great Britain Overseas Development Administration and the Department of Clinical Physics and Bioengineering in Glasgow. The latter project, successfully progressing since 1978, was designed primarily to provide manpower development facilities and to build a service organization for using medical equipment maintenance engineers and technicians. The project was given high priority, since it was recognized that much existing equipment was ineffectively used or inoperable for lack of engineering staff, and that successful future technology transfers would require the presence of a skilled and well-organized group of such personnel.

In this case the "model" adopted by the Egyptian Department was based on one developed in Glasgow, but many modifications were required to adapt it to local circumstances. The following elements were crucial:

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[25] According to a representative of Hospitalia International—a company which has established some 400 hospitals in LDC's—a hospital in Saudi Arabia should budget between 15 to 20 percent of its medical expenditures for effective maintenance of equipment, compared to about 5 percent in a Western hospital. This 15-20 percent figure could be reduced if the hospital were to follow some of these suggestions:

- Make serviceability an important criterion for selection of equipment.
- Understand the importance of standardization, which not only reduces the cost of basic equipment, but also permits staff to move around among various clinics and provides the opportunity to improve service since consumables, reagents, and spare parts can be obtained in quantity and stored centrally at lower costs.
- Allow the installation personnel stay on the job to train staff in appropriate utilization.
- Include a spare parts package included in the original contract.
- Establish a preventive maintenance schedule for the technical maintenance team.
- Make sure that all documents and manuals are onsite and in the proper language.

- The close coupling of manpower development activities to the needs of the health services, thus ensuring that training was relevant to the needs and also attracting user support.
- Ongoing institution-to-institution links between the Abbassia and Glasgow Departments. This involved long-term exchanges of staff which helped keep objectives on target, gave continuity, and built mutual trust and respect.

Local Production of Medical Equipment and Supplies

Local production of medical supplies and equipment is very limited in the six countries under study. More than 90 percent of their medical equipment is imported.

Prospects for local production vary. Currently, local production is negliable in Saudi Arabia and Kuwait. In both cases, the domestic markets are comparatively small and scarce labor resources are committed to other types of manufacturing operations. In neither case is it likely that local production will substantially displace imports of medical equipment and supplies during the next 10 to 15 years.

Prospects for local production are much better in Egypt and Algeria. Egypt has plans to locally design and assemble more sophisticated medical equipment. To date, however, production has been limited to supplies of nonchemical consumables, and custom-built items such as prostheses used in rehabilitation. Many firms are also involved in manufacturing beds, chairs, and kitchen and laundry equipment used in medical facilities.

Algeria did not produce medical equipment or disposables locally in 1980. Although the current 5-year plan stresses the importance of a domestic industry in this sector, implementation of these plans by 1990 is uncertain. Any manufacturing unit established is likely to produce initially simpler kinds of equipment and disposable articles. The Algerian national steel industry is working on a project to produce simple medical equipment. This project will probably not materialize until after 1985, if at all. Even if domestic production of medical equipment does begin in the next few years, Algeria will probably remain strongly dependent on imports of medical equipment for the next decade.

Iraq's local production of medical equipment and supplies is limited, and imports accounted for approximately 90 percent of the market in 1980. There are no plans to produce medical equipment locally. West German, Japanese, and French equipment constituted about 70 percent of total medical equipment imports in 1980.

Iran produced no medical equipment and only limited medical supplies in 1978. Total imports of medical equipment and supplies in 1978 were $50 million, with West Germany, the United States, Japan and the United Kingdom as the main exporting countries, in that order. Almost 80 percent of the imports were channeled through local dealers. Most foreign suppliers were on contract to install and maintain their equipment, and in the latter half of the 1970's several joint venture companies were established to service government medical facilities.

Despite the fact that local production of medical equipment is limited, there is a strong rationale for it in Middle Eastern countries. The forms of local production theoretically feasible are design of basic medical equipment systems, local assembly of instruments and apparatus under license agreements, and design and assembly of medical equipment from locally manufactured or imported subsystems. The major reason for local involvement would be to produce simpler and cheaper equipment, which may be more appropriate to local needs. This is especially true since many users in the region feel that the imported equipment is often overengineered.[26] Local production also promotes technology transfer and saves foreign exchange. In the future, Middle Eastern countries such as Egypt, Algeria (and Iran and Iraq) may significantly expand local production of medical supplies and equipment, but imports will remain significant for many years.

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[26] Of the countries of concern in this report, a debate on the question of local production and on appropriate medical technology is going on only in Egypt. Several persons interviewed at Egypt's MOH and Cairo University felt that most imported

Hospital Design and Construction

Capabilities in hospital design and construction in the Middle East vary widely. In Saudi Arabia, turnkey hospital construction has been dominated by Western contractors, who still have a competitive edge over their Far Eastern competitors. Consultants, mostly from Western Europe and the United States, often do feasibility studies, design, and planning. In turnkey hospital construction, the contractor is responsible for all parts of the project. Equipping and supplying the hospital can be performed by the original company or can be subcontracted to a medical equipment company or a consultant. The largest hospital constructor in Saudi Arabia, Philip Holzmann, has several arrangements for equipping hospitals, depending on the project. If the firm does not itself provide equipment, it may use the services of an international turnkey hospital subcontractor such as Hospitalia, or international equipment firm such as Labsco, or a Saudi equipment agent such as Dallah Medcenter.

In Egypt, owing to the limited allocations for new hospital construction in the last few years, the activities of foreign firms have been limited. Domestic firms carried out a major share of the construction, while European (mostly British) and some U.S. firms are cooperating with Egyptian counterparts in hospital design and civil engineering.

In Algeria, the more comprehensive hospital construction projects are the university hospitals, with the current plan calling for seven new university centers, all designed by foreign consultants from Great Britain, Sweden, Finland, Japan, and the United States.[27] The construction is a cooperative effort between foreign and local contractors.

In both Iraq and Iran hospital design and construction have been carried out by both local and foreign companies. Iran had quite a few good consulting architects who were able to work with or without their Western counterparts. Present efforts, owing to the war, are directed at maintaining existing infrastructure.

Hospital Management

Another prominent type of medical technology transfer in certain countries in the Middle East, particularly Saudi Arabia, has been staffing and management of hospitals. Companies like Hospitalia (a West German/Dutch joint venture) or Hospital Corporation of America (HCA) of the U.S. offer complete consulting, supply, installation, and maintenance services, but not construction.

To date, only the MODA and the National Guard have contracted out the running of hospitals to foreign companies. MOH has not followed their lead, on the grounds that such a policy might inhibit development of Saudi expertise. Others say that hospital management can be carried out in such a way as to promote indigenous medical expertise. With several constructed hospitals not operating because of insufficient staff, and in view of the ongoing hospital building program, the Ministry's stance on foreign contractors may change.

In the last 5 years, Kuwait has been reluctant to become involved in the turnkey ap-

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medical equipment was "over-engineered" for a country—like Egypt—which has limited financial resources available to finance imports and wants to extend health coverage more widely.

One example of adapting medical technology to specific markets is Johnson & Johnson Co., Ortho Diagnostics Division, which assesses appropriate technology and product use for each potential foreign market. The potential user has the option to choose the level of technology which is right for him. See "Appropriate Health Care Technology Transfer to Developing Countries" (Millwood, Va.: Project HOPE, 1982).

[27] The foreign consultants are Devecon Arkitekter, Helsinki, Finland, for the University Hospitals of Annaba and Setif; Uniconsult Arkitekt, Stockholm, Sweden, for the University Hospitals of Constantine and Alger; Kenzo Tange, Tokyo, Japan, for the University Hospital of Oran; Skidmore, Owens, and Merrill, U.S., for the University Hospital of Blida; W.S. Atkins Architects, London, Great Britain, for the University Hospital of Tlemcen. *World Health Markets, Algeria* (West Sussex, Great Britain, 1982).

proach to hospital construction, staffing, and administration.[28] Therefore, the new public health hospitals were specified, equipped, and commissioned by MOH. The original designs by Western consultants were redrawn with the consultation of WHO specialists. These hospitals will be among the best equipped in the world.[29] All equipment for government facilities must be purchased through Kuwaiti agents.

Kuwait has recruited mainly in the East, to attract medical staff. Agreements with foreign universities and governmental agencies have also been made in order to improve administrative and planning capacity. One such example is an agreement with the Johns Hopkins University to provide assistance in a new 20-year plan for Kuwait's health services.

A few international companies have been involved in private Egyptian hospital projects, but on a limited scale. The U.S.-based American Medical International (AMI), terminated its management and staff contract in 1982 with the prestigious private 300-bed As Salam hospital.[30]

The need for additional hospital management expertise in Egypt has not been adequately addressed. A report on Egyptian health care noted that there is a desire for such training on the part of physicians serving as administrators in rural health work, as well as on the part of supervising nurses in hospitals.[31]

In both Iraq and Algeria, the turnkey approach to hospital design, construction and management has not been popular. Algeria has attempted to limit involvement of foreign medical personnel. The Iraqi Health Ministry is apparently confident enough in its staffing and managerial skills to organize the second phase of the Baghdad Medical City project itself. The South Korean firm Hyundai was awarded a contract fo construction, but the Iraqis themselves are coordinating the project. In Iran management and staffing were largely taken care of by the Iranians themselves in the late 1970's.

Training of Local Personnel

Medical Manpower Development Plans.—Saudi Arabia is overwhelmingly reliant on expatriates to run its hospitals. Saudis make up only 5 to 8 percent of the doctors and about 10 to 15 percent of the nursing staff, with most of these being naturalized citizens.

The ratio of physicians to beds in Saudi Arabia should rise, considering the number of students currently studying in the four medical schools or abroad, but it will not rise significantly, since the number of hospital beds is also increasing. By 1986, MOH will be responsible for some 20,000 beds, compared to the present 13,000. The number of doctors, nurses, and technicians is projected to increase by more than 60 percent. Medicine is a popular curriculum among Saudi students, many of whom study abroad. When the Saudi students return,[32] they generally need additional special training to practice in the Kingdom.[33]

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[28] One of the reasons for Kuwait's reluctance to become involved in turnkey hospital construction is the relatively high level of competence of their Ministry of Public Health. There are also agreements between the Health Ministry and WHO and between the ministry and Great Britain Regional Health Authority, whereby both organizations supply consultation services in training, design, and equipping. Also there are several competent joint venture construction firms based in Kuwait which are able to build hospitals with assistance from the European joint venture partners.

[29] The KD 10,000 budget is for equipment and supplies. It is estimated (*Kuwait Times*, Feb. 24, 1982) that the annual operating cost for the 500-bed Al-Adan Hospital will be in the region of KD 16 million—about $53 million—corresponding to an annual cost per bed of about $106,000, which is comparable to (or even above) expenditures for a Western hospital.

[30] According to an interview in *Middle East Health Magazine*, Great Britain, September 1982, a representative of AMI Overseas Operations explained the major reasons for AMI's termination of the contract as being:

1. The costs ran far over budget and substantial payments were not honored;
2. Changes in AMI's contract were made that reduced the company's degree of control over the hospital management (mainly the right to select and hire key staff);
3. The excessive time taken to supply water, electricity, and sewerage service;
4. The failure to release hospital equipment through customs; and
5. As a result of the above, expatriate administrative staff spent 9 months doing very little.

[31] AID, "A Report on Egyptian Health Care: A Sector in Transition," May- June, 1982.

Traditional attitudes affect manpower in medical services. The role of women, for example, is limited by a tradition that male patients should not be cared for by women from outside the immediate family. The nursing profession is also considered low in prestige even among women who have few other work opportunities open to them. These attitudes are being relaxed to allow Saudi women to train and work as nurses, although facilities and staff are still extremely limited.

Kuwait also has a large expatriate work force in the medical service sector. Table 74 disaggregates the medical labor force, by sex and by occupational groups The Kuwaiti health work force increased substantially over the 10-year period. As in Saudi Arabia women represent a low proportion of the total work force, particularly in nursing. According to the Kuwaiti census, the largest number of non-Kuwaiti physicians were Egyptians, Jordanians, Palestinians, and Indians, representing approximately 45 percent, 21 percent, 7 percent, respectively, of the total number of government physicians (2,102) in 1980. Kuwaitis comprise approximately 16 percent of the physicians.

The Kuwait Health Plan specifies future manpower requirements, as seen in table 75. The largest percentage increases will be among dentists (400 percent), technicians (211 percent), pharmacists (193 percent), and nurses (157 percent). Except for dentists, Kuwaiti nationals will continue to make up a small share of these medical professionals.

In contrast to the modest expansion of health facilities during the past decade, Algeria's performance in training health personnel has been impressive. Table 76 shows the increase in medical and paramedical personnel from 1969 to 1978. The greatest gains in this area have been made in the training of paramedical staff, who are well suited to preventive rather than curative care, which is emphasized in Algeria. Between 1969 and 1978, the number of Algerian physicians in the country increased more than sixfold—from 521 in 1969 to 3,156 in 1978. As a result, the country's reliance on expatriate physicians was substantially reduced. Paramedical personnel increased from a total of 6,377 in 1969 to 23,658 in 1978. The very rapid increase achieved in paramedical personnel during the past decade is projected to continue with even greater strength: 4,000 paramedical technicians and 26,000 paramedical agents are scheduled to complete training between 1980 and 1984. If this very ambitious training goal is attained, it will lead to a more than doubling of the nation's paramedical personnel. To meet these goals, Algeria has signed several bilateral

Table 74.—Labor Force in Kuwait by Sex and Occupation Groups: Census of 1965, 1970, 1975

		Censuses					
		1965		1970		1975	
Occupation groups and sex		Non-Kuwaiti	Kuwaiti	Non-Kuwaiti	Kuwaiti	Non-Kuwaiti	Kuwaiti
Physical scientists and	M	193	13	251	47	538	95
related technicians	F	3	—	36	6	183	54
Physicians, dentists, and	M	473	23	609	44	820	76
veterinarians	F	70	1	111	3	182	27
Professional nurses	M	952	49	176	—	1,626	334
	F	1,185	23	1,639	57	2,703	178
Pharmacists and other	M	501	207	1,287	289	486	107
medical related workers	F	37	25	98	9	51	15

SOURCE: Kuwait Ministry of Planning, *Annual Statistical Abstract 1981*, (Edition XVIII), Kuwait Central Statistical Office, 1981, pp. 108-11.

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[32] Saudi students have always had a relatively high return rate compared to other Middle Eastern countries. In addition, in the United States at least, new immigration laws targeted at medical students make staying in the host country difficult.

[33] From interviews with U.S. physicians with experience in Saudi Arabia, the students will need further training in three specific areas, namely: 1) experience with treatment of specific Saudi or Middle Eastern diseases; 2) experience with different attitudes of Saudi patients, who sometimes view the doctor with skepticism; 3) experience in operating independently of the professor and others from whom the student learned.

Table 75.—Total Kuwaiti Manpower Requirements for 1985, 1990, and 2000 Compared With December 1980 Staff in Post[a]

Staff group	December 1980 staff in post		1985		1990		2000	
			Number	Percent change from 1980	Number	Percent change from 1980	Number	Percent change from 1980
Physicians	1,918	(14%)[b]	2,411	25.7	3,017	57.3	4,136	115.6
Dentists	182	(43%)	393	115.9	525	188.5	911	400.0
Pharmacists	272	(18%)	476	75.0	579	112.9	798	193.4
Administrative	3,688	(52%)	4,452	20.7	5,883	46.0	7,383	100.2
Technicians	3,156	(27%)	5,594	77.2	6,867	117.6	9,806	210.7
Nursing staff	6,881	(7%)	9,449	37.3	11,898	72.9	17,648	156.5
Vocational workers	5,100	(42%)	6,223	22.0	6,501	27.5	7,432	45.7
Laborers	4,906	(8%)	6,021	20.8	7,023	40.9	9,443	89.4
Total	26,183	(24%)	35,019	33.7	41,793	59.6	57,557	119.8
Population (000's)	1,355.8	(41%)	1,728.9	27.5	2,098.3	54.8	2,891.5	113.3

NOTE: Manpower Requirements do not include staff numbers to replace resignations.

[a] By main staff group with percent increase for each year from the December 1980 figures.

[b] Figures in brackets for December 1980 show percent Kuwaiti.

SOURCE: Kuwait Health Plan 1982-2000, vol. 4, Executive Summary, p. V-12.

Table 76.—Algerian Medical and Paramedical Personnel

	1969	1972	1974	1975	1976	1977	1978
Physicians							
Algerian	521	784	1,125	1,420	2,027	2,726	3,156
Foreign	1,179	1,201	1,253	1,392	1,448	1,295	1,752
Pharmacists							
Algerian	206	317	341	549	664	666	708
Foreign	59	38	101	52	41	40	41
Dentists							
Algerian	142	211	350	469	553	713	813
Foreign	80	97	84	88	90	120	138
Paramedical technicians	477	667	917	1,098	1,167	1,233	1,922
Specialized paramedical agents	460	342	426	620	696	743	432
Paramedical agents (nurses)	1,634	3,088	4,672	6,056	7,857	9,719	11,040
Paramedical aides	3,806	6,271	8,355	9,008	9,092	9,789	10,264
Total paramedical personnel	6,377	10,368	14,370	16,782	18,812	21,484	23,658

SOURCE: World Bank, *Algeria, The Five-Year Plan, 1980-84*, Washington, D.C., 1980.

agreements for medical service training especially with France.[34]

Table 77 shows the demand and supply of manpower by occupation during the Fifth Plan of Iran. A shortage of 1,300 people was predicted for senior medical personnel, while the shortage of other medical personnel was predicted to be as high as 21,300. In the past, most Iranian medical students went abroad for their postgraduate training.

Training Experiences of Hospital Management Corporations.—Both former Saudi Ministers of Health, Drs. Jazairi and Algosaibi, have expressed concern that foreign firms have been more worried about profits than about technology transfer.[35] U.S. management firms, for their part, say that training local staff is the only viable long-term means for promoting technology transfer, and that it is consistent with their strategies.

All U.S. hospital management firms working in the Middle East train local professional staff. This is a contractual duty in Saudi Arabia, where specific requirements include numbers or percentages for local staff. Large U.S. hospital management firms operating in Saudi Arabia employ as many as 3,000 personnel, of which about 10 percent have been Saudi nationals in recent years. In one instance, the majority of the local staff held positions as drivers, but in another instance the chiefs of medicine, pediatrics, and the hospital director were all Saudi nationals.

Evaluations of experiences with training differ, but U.S. firms have been skeptical about achievements. In one case, a U.S. firm maintained that it was difficult to fill required positions with Saudi trainees, because most candidates prefer to enter a business profession. Another company reported that, despite its efforts to recruit Saudis and its arrangements to facilitate their enrollment in U.S. institutions, success has been minimal. In both cases, on-the-job training techniques are stressed, and new curricula have been designed which include instruction in Arabic as well as English. To summarize, both Saudi Arabian officials and U.S. firms express their belief that goals have not been achieved.

Training at a U.S. University.—One example of an assistance program between a Middle Eastern medical school/university hospital and a U.S. medical school was the project between the King Saud University Hospital in Riyadh and the University of Colorado

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[34] Algeria and France have signed several agreements in the past 10 years primarily involving exchange of teachers and students. In conjunction, French firms have won contracts for design and construction of medical facilities.

[35] Dr. Ghazi Algosaibi became Ministry of Health in October 1983 after several months in the postion of acting minister. He was dismissed in late April 1984 after incurring the disfavor of senior members of the Saudi royal family. See Michael Field, "Controversey on Dismissal of Saudi Minister," *Financial Times*, Apr. 25, 1984, p. 1.

Table 77.—Demand and Supply of Manpower by Occupation During the Fifth Plan for Iran (1,000 persons)

Category	Demand[a]	Supply	Shortage
Architects, town planners, and civil engineers	7.8	4.0	3.8
Electrical and electronic engineers	5.5	2.8	2.7
Mechanical engineers	6.9	4.2	2.7
Chemical, mining, and metallurgical engineers	2.0	1.0	1.0
Other engineers	14.2	8.3	5.9
Senior medical personnel	8.5	7.2	1.3
Other medical personnel	35.6	14.3	21.3
Educational personnel	287.4	230.0	57.4
Higher educational personnel	22.5	21.0	1.5
Technicians	116.6	75.0	41.6
Other technical and vocational personnel	8.0	4.0	4.0
Managerial, administrative, and sales personnel	185.0	185.0	—
Mining, drilling, and extractive workers	23.0	15.0	8.0
Transport workers	41.0	41.0	—
Skilled and semiskilled industrial workers	520.0	230.0	290.0
Skilled construction workers	290.0	20.0	270.0
Unskilled workers	538.0	528.0	10.0
Total	2,112.0	1,390.8	721.2

[a] Demand for additional workers in each category to enter the work force during the 1973/74-1977/78 period.

SOURCE: Plan and Budget Organization of Iran and Fifth National Development Plan, as reported by the U.S. Department of Commerce, 1978.

School of Medicine in the United States. The contract was signed in 1981, but the Saudis requested that it not be continued beyond February 1984. The program included advice on curricula and faculty facilites in Saudi Arabia, supply of U.S. hospital administrators and faculty members for periods of a few months to up to 2 years, and teaching of Saudi students in their last year of education.

By the beginning of 1983, the university had supplied 35 administrators and 10 faculty members, including two groups in oncology and one group in pediatrics, for 3 to 6 months. One problem was difficulty in recruiting U.S. faculty members to the program. According to a university representative, faculty members were reluctant to leave the research program at Colorado, and their families were hesitant to move to Saudi Arabia.

Only three Saudi students (all female) were sent to Colorado. They arrived with limited knowledge of English, and eventually decided to return to Saudi Arabia before completing their training. This was the result of a number of problems, the fundamental one being that that Saudi medical students do not gain clinical experience in their course of study in Saudi Arabia, and therefore find it difficult to make the transition to the U.S. program, which strongly emphasizes hospital experience. In this case, there was limited space at the university and the hospital for additional students, and the foreign students needed special individual training. The Saudi students had difficulties in meeting the stiff U.S. requirements for both residency and examination.[36] This experience indicates the importance of careful preparation, both in the U.S. organization and in the Middle East country, prior to beginning training. According to U.S. participants, this experience should not be taken to indicate that such programs cannot succeed, but rather that special preparation in clinical experience must be provided. This means that Saudi medical training must be augmented with special courses in order for such student exchange programs to function effectively.

Experiences From U.S.-Sponsored Health Care Activities in Egypt.—Cooperation between Egypt and the United States in training and educational activities occurs mainly through AID programs. These projects have included some funded under the Special Foreign Currency Program.[37] Nonprofit private organizations like Project HOPE are also involved.

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[36] Foreigners who want to come to the United States to study medicine or to practice medicine must pass the Visa Qualification Examination. The tests are closely related to the regular examination of U.S. medical students administered by the National Board of Education. The VQE is a difficult examination, and the percentage of those passing is about 20 percent. Source: American Medical Association, Chicago, Ill.

Health has been a priority area for AID programs. AID-sponsored health programs, which currently involve 35 different projects, concentrate on preventive medical services such as oral rehydration, family planning, mass immunizations, and school health. Appendix A includes a list of major AID projects in the health field in Egypt. The total funding for the entire life of these projects initiated over the past 8 years is $261 million. In addition, $24 million has been allocated under the Commodity Import Program for procurement of medical equipment.

One example of an AID program is the Suez Canal University Community Health Personnel Training Project, which includes cooperation between Boston University, the Egyptian MOH, and the Suez Canal University. The project was initiated in 1980 with the objective of establishing an integrated medical education and health services program for five governorates bordering the Suez Canal. The project assists in developing a new curriculum and a new mode of teaching physicians, and provides preventive and community-based primary health services. One unique aspect of the training is the involvement of students with care of patients. Another is the training in the United States of up to 50 junior and senior faculty members each year in primary health service courses that are not available in Egypt. Through group practice, the program emphasizes bringing needed primary health care to the surrounding community. The project was established in 1980, and was given high marks in an evaluation carried out in late 1982.[38] As the program becomes more complex with the addition of new courses, one central challenge will be for the Faculty of Medicine to effectively coordinate efforts with the Ministry of Health. This specialized training program represents an example of U.S. assistance contributing to the upgrading of health manpower skills in a focused way to meet the needs of the community.

The U.S.-Egypt Special Foreign Currency Health Program has concentrated on improving local research capabilities, mainly in treating epidemiological diseases, in environmental health and health services. The program has included some 400 projects, running from 1 to 5 years (sometimes more) with total budgets ranging from $10,000 to several million dollars. These normally involve a U.S. funding institution (often the Department of Health and Human Services), a U.S. project officer either from the funding institution or from a university, and an Egyptian counterpart from a university or from MOH. Collaborative research designed either to advance knowledge or solve development problems has been the central focus. Successful projects have involved capable researchers in well-run laboratories, adequate salaries, and an American research partner.

One program jointly financed by AID and the Special Foreign Currency Program is an Emergency Medical Services (EMS) system. This project was started in 1976 at the strong recommendation of the Egyptian Ministry of Health, with specific objectives to:

- Establish a viable EMS entity in the MOH and an appropriate organization in each of the designated governorates.
- Train physicians, nurses, and technicians in basic and advanced life support treatment.
- Establish national standards for EMS in manpower, communications, critical case units, disaster planning, emergency departments, and public information.

Most of the objectives of the EMS system were attained. Key accomplishments were the establishment of five EMS training centers, purchase of over 600 ambulances, updating of emergency departments in the demonstration project hospitals, successful training of over

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[37] No new funds have been allocated to the SFC since October 1981. This fund is part of the Public Law 480 program, which involves assistance projects payable in foreign currency. Projects in the health field supported by these funds have mostly included research and provision of equipment for laboratories. Some of the projects may be continued through funding from AID.

[38] See "Evaluation Report of the Suez Community Health Personnel Training Project" (Cairo: AID, Oct. 12, 1982).

Photo credit: U.S. Agency for International Development

Emergency medical services in Egypt

2,400 students and nurses in basic life support, U.S. training of physicians, and recruitment and training in basic life support of 850 ambulance attendants. Communication equipment was installed in 15 MOH hospitals. However, despite the fact that the project met many of its goals, it was criticized as too costly and dependent on high technology. The primary beneficiaries of the project were an elite group who have telephones and are able to use the service.[39] For these reasons, an assessment team recommended that the project not be funded further. Although the EMS project was a program which the Egyptian government viewed as a high priority and one which achieved many of its goals, it was evaluated quite differently by observers who emphasized provision of basic health services to the average citizen.

Overall, AID's health programs have made an important contribution to improving health care in Egypt, with a special emphasis on projects that involve direct and high-impact medical services to the population. These programs generally have been distinguished by their broad coverage and emphasis on provision of medical services needed by the average Egyptian citizen.

A third area for U.S.-sponsored health care transfer is the HOPE-sponsored activities in Egypt. These have concentrated on three major areas: biomedical engineering, nursing education and scientific exchange. HOPE works jointly with Cairo University, MOH, the Ministry of Higher Education, and the National Academy of Science, with the objective of giving Egypt self-sufficiency in biomedical engineering. HOPE is involved in developing a new Institute of Nursing at Assiut University. Currently, 50 U.S. student nurses are being recruited for teaching positions. The nursing program emphasizes clinical training and preventive health practice in a densely populated but rural part of Egypt. More than 200 Egyptian and U.S. health scientists have participated in HOPE's Scientific Exchange Program since 1975.

Major reasons given for HOPE's success include concentration on high-quality teaching activities and on health areas which have a high priority in Egypt, its status as a small but effective organization without any political attachments, and a strong feeling of commitment on the part of HOPE personnel.

Evaluation of the Level of Medical Technology Absorption

While there are no accepted measures of technology absorption, a number of factors can be used to gauge the overall quality of medical technology and local capability to use it: 1) facility design and construction, 2) equipment, 3) staff, 4) education and training, 5) R&D programs, and 6) the ultimate benefit to the respective patient.

An evaluation of the level of medical technology absorption based on these indicators must be used cautiously—partly because the information available is not complete, and partly because the available indicators are not comparable in quantity or quality.

Table 78 summarizes OTA's estimates of the extent and use of medical technology in the Middle Eastern countries under study

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[39] See AID, "A Report on Health Development in the Arab Republic of Egypt," May 7-June 10, 1982, pp. 36 and 61.

Table 78.—Estimated Level of Medical Technology Absorption in the Middle East Countries Under Study[a]

Individual factors	Saudi Arabia	Kuwait	Iraq	Egypt	Algeria
(1) ***Facility design and construction***					
Overall quality	H	H	M	L	L
Local capability to design and construct	L	VL	L	M	L
(2) ***Equipment***					
Overall quality	H	H	M	L	L
Local production capability	VL	VL	VL	L	VL
Overall operability and serviceability	L	M	L	L	L
Local capability to operate and maintain	VL	VL	L	M	L
(3) ***Personnel***					
(a) Physicians					
Total number/0000 population	L	H	L	M	VL
Percent local	VL	VL	L	VH	H
Overall quality	H	H	M	M	M
Local quality	L	L	L	M	L
(b) Nurses					
Total number/0000 population	L	M	L	L	L
Percent local	VL	VL	L	VH	H
Overall quality	M	M	M	M	L
Local quality	VL	VL	L	M	L
(c) Technicians					
Total number/0000 population	VL	L	L	M	VL
Percent local	VL	VL	VL	VH	L
Overall quality	M	M	L	M	L
Local quality	VL	VL	L	M	VL
(d) Administrators					
Total number/0000 population	M	M	L	L	M
Percent local	L	M	M	VH	M
Overall quality	M	M	M	L	L
Local quality	L	M	M	L	L
(4) ***Education, training***					
(a) Physicians					
Number of students and funding	H	M	M	H	L
Quality	M	M	M	H	M
(b) Nurses					
Number of students and funding	VL	L	M	M	L
Quality	VL	L	L	M	L
(c) Technicians					
Number of students and funding	VL	VL	L	M	L
Quality	VL	VL	VL	M	L
(d) Administrators					
Number of students and funding	L	M	L	L	L
Quality	L	M	L	L	L
(e) On-the-Job Training					
Overall scope	L	L	VL	M	L
Quality	VL	VL	VL	M	L
(5) ***R&D programs***					
(a) Overall scope	VL	L	VL	M	L
(b) Local capability	VL	L	L	M	L
(6) ***Extent of use of medical technology among patients***	L-VH	M-VH	L-H	VL-H	VL-M

KEY: VH—Very High; H—High; M—Moderate; L—Low; VL—Very Low when compared to U.S. or European standards.

NOTE: These estimates are based on expert judgments and are presented as illustrative of variation. The estimates should be used only as general references.

[a] Iran is excluded, due to lack of current information.

SOURCE: Office of Technology Assessment.

(Iran is excluded, owing to lack of relevant, recent information). A very high (VH) notation indicates that the facility or personnel are on a par with those in the United States or Europe. Overall, medical technology absorption has been limited in the Middle East. Kuwait and Saudi Arabia have the highest overall range and quality of available medical technology, but absorption has been very limited. This is the case because much of their medical service is, and will continue to be, provided by expatriates at least for the mid-term. Egypt presently has the highest level of absorption in medical services owing to its large, trained, medical personnel base. Egypt, among the countries studied, has the greatest indigenous capability to operate and maintain medical equipment. The quality of indigenous Egyptian medical personnel is comparatively good; infrastructure and poor administration are major obstacles. Algeria has, until now, been relatively successful in training indigenous medical personnel. Its ambitious social plans, however, coupled with weak medical education and training programs, strained ability to maintain large gains in training nationals in the past few years. In this regard, Iraq falls somewhere between Saudi Arabia and Kuwait on the low end and Egypt and Algeria on the high end. Iraq's strongest suit is in administration, but the country's civilian medical programs have been constrained by the Iran-Iraq war.

PERSPECTIVES OF SUPPLIER COUNTRIES AND FIRMS

Judging from the state of health care and health care facilities in the Middle East and government policy statements, the general needs and specific requirements for medical services technology in the Middle East are substantial, diverse, and changing. The prospective commercial supplier of medical technology services must be aware of the distinction between the need for medical technology and the effective demand for it, which could be defined as the ability and willingness to purchase the technology at a given price.

In this section, characteristics of the market for medical equipment and services are briefly reviewed. Dissimilarities in technology transfer and market approaches taken by firms from various supplier nations are identified. The competitive position of U.S. firms is then analyzed; their advantages and disadvantages in promoting technology transfers in the medical sector are identified. U.S. firms are on a technological par with other foreign supplier firms, but poor after-the-sale service is one factor limiting U.S. sales. Finally, incentives and objectives of noncommercial suppliers are reviewed.

THE MIDDLE EAST MARKET FOR MEDICAL EQUIPMENT AND SERVICES

Hospital design and construction, equipping medical facilities, and hospital management are the dominant types of commercial transfers of medical technologies in the Middle East.

Medical Equipment and Supplies

The market for medical equipment and supplies—excluding pharmaceuticals—in the six countries concerned plus the three small Gulf States of Qatar, Oman, and the UAE, was estimated at approximately $250 million in 1980.[40] The corresponding market in 1975 was estimated to be about $95 million. The Middle East medical equipment market grew rapidly; at a rate of 20% annually in recent years. Nevertheless, imports of medical equipment were valued much lower than imports of construction and technical services, discussed below.

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[40] U.S. Department of Commerce, Washington, D.C., "Market Surveys—Medical Equipment," 1981.

Table 79 shows total imports of medical equipment and supplies for the six countries of this study, and the market shares of the major supplying countries. In Kuwait, U.S. firms held the greatest market shares and they earned the second-largest market share in Saudi Arabia in 1980. In addition, combined total imports of medical equipment and supplies in Qatar, Oman, and the UAE were $17 million in 1980. The United Kingdom was the dominant supplying nation for this group (with almost 35 percent of total imports), with the United States having a market share of approximately 12 percent.

Care should be taken in reviewing statistical information on medical equipment imports, because substantial shifts in the total market and in the ranks of the suppliers can occur from one year to the next. This has been the case for Algeria, owing to bulk purchases and/or specific requirements for one or two large hospital complexes.

U.S. exports[41] of medical equipment to the world in 1980, excluding Canada,[42] totaled $1.7 billion, of which approximately 3 percent went to the Middle East ($60 million). See table 80.[43] The large domestic (and Canadian) market for U.S. medical equipment and the relatively small Middle Eastern portion of such U.S. exports has been cited as one reason why U.S.

Table 79.— Imports of Medical Equipment and Supplies, 1980

	Imports (million)	Market share (percent)
Saudi Arabia—Total imports $84 million		
West Germany	$30	36
United States	$20	24
United Kingdom	$11	13
Japan	$ 7	8
Kuwait—Total imports $30 million		
United States	$10	33
West Germany	$ 4	13
Italy	$ 3	10
United Kingdom	$ 3	10
Egypt—Total imports $40 million		
France	$10	25
West Germany	$ 6	15
United States	$ 5	12.5
United Kingdom	$ 5	12.5
East Germany	$ 3	7.5
Algeria—Total imports $18 million		
France	$ 8	48
West Germany	$ 4	21
Belgium	$ 2	10
United States	$ 0.8	4
Iraq—Total imports $28 million		
West Germany	$ 8	29
United Kingdom	$ 4	14
France	$ 4	14
Japan	$ 3	11
United States	$ 2	7
Iran (1978)—Total imports $41 million		
West Germany	$12.5	30
United States	$ 8	20
Japan	$ 5	12
United Kingdom	$ 4	10

SOURCE: Compiled for Office of Technology Assessment based on data collected by Middle Eastern countries

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[41] Data collected by U.S. Bureau of the Census, Washington, D.C., in *U.S. Exports/Schedule B Commodity by Country*, Report FT 446, published annually.

[42] The U.S. export market to Canada in this sector is large and would add approximately 20 percent to the world total exports.

[43] The $60 million export figure does not match the total of $45.8 million of imports from the United States from the preceding table, owing to different data sources and different medical supplies which are included in the tabulations.

Table 80.—U.S. Exports by Industry Sector and Subgroup to the World (excluding Canada) (value in $000) Industry Sector: Medical Instruments, Equipment, and Supplies

SITC Number	Product Description	1978	1979	1980
Medical instruments				
7741010	Pacemakers	39,847	41,006	46,447
7741020	Diathermy units	417	450	760
7741030	Ultrasound therapeutic devices	7,969	6,624	8,056
7741040	Other therapeutic apparatus	40,216	59,704	74,027
7741050	Electrocardiographs	7,074	8,687	8,621
7741060	Electroencephalographs	1,415	2.056	1,226
7741070	Complete patient monitoring systems	29,153	34,050	53,449
7741080	Electro-medical apparatus, NSPF (not specifically provided for)	153,463	193,030	238,742
7741090	Electro-medical apparatus parts	55,772	97,003	103,111
7742010	X-ray tubes	4,350	5,717	8,214
7742020	Parts for X-ray tubes	1,157	1,521	3,618
7742030	X-ray apparatus and parts for medical or dental use	97,357	145,029	153,043
7742050	Radiological apparatus and parts for medical or dental use	17,251	22,000	17,713
8720405	Ophthalmic instruments and appliances and parts	23,745	28,450	29,360
8720410	Anesthetic apparatus and instruments and parts (except syringes)	7,955	8,889	10,670
8720415	Bougies, catheters, drains, and sondes and parts	38,367	51,335	63,103
8720420	Basal metabolism and blood pressure apparatus and parts	17,054	20,167	23,430
8720425	Hypodermic syringes and parts	11,050	16,034	20,221
8720430	Other syringes and parts, NSPF	3,380	5,826	7,963
8720450	Other medical, etc. instruments and apparatus and parts, NSPF	149,416	159,521	179,584
Total for industry subgroup—Medical instruments		706,436	908,867	1,051,374
Medical and hospital appliances and equipment				
7416016	Sterilizers and autoclaves and parts	14,818	16,161	18,549
7853020	Wheelchairs and parts	2,730	2,649	3,135
8212100	Other hospital, medical, dental, etc., furniture, NSPF	35,334	38,689	53,249
8720320	Mechano-therapy appliances and massage apparatus and parts	8,000	6,457	8,299
8720340	Artificial respiration, ozone, oxygen, aerosol therapy, etc.	50,391	60,143	77,928
8996100	Hearing aids and parts, NSPF	6,383	7,899	9,645
8996250	Bone and joint prosthesis, plates, screws, nails, etc.	26,168	31,751	36,588
8996280	Other orthopedic appliances	20,938	21,117	26,292
Total for industry subgroup—Medical and hospital appliances and equipment		164,762	184,866	233,685
Dental instruments and equipment				
5419060	Dental cements and filling (except alloys)	14,279	13,513	22,798
5988025	Dental impression plates	3,519	3,977	5,304
8720440	Dental hand instruments and parts	13,766	19,184	23,279
8720445	Other dental and instruments, NSPF	24,002	34,202	41,853
8996225	Artificial teeth and dentures of plastic	2,726	4,725	6,092
8996240	Other artificial teeth and dentures, NSPF	6,155	7,898	9,048
Total for industry subgroup—Dental instruments and equipment		64,387	83,499	108,374
Medical supplies				
5419010	Opacifying preparation for radiological examination	6,041	8,124	10,252
5419020	Other diagnostic agents (except biological), NSPF	39,839	52,154	53,650
5419030	Waddings, gauze, dressings, etc. with medicinals	6,405	5,594	5,099
5419040	Other waddings, etc., NSPF	19,455	24,198	30,845
5419050	Surgical sutures and materials, etc., sterile	32,320	36,600	36,845
8482020	Surgical and medical gloves	14,642	19,427	29,189
8720435	Hypodermic needles	7,071	7,700	10,617
8822620	X-ray film, medical, ex dental	35,900	45,803	72,720
8822625	Other X-ray film	10,953	11,623	23,511
8841120	Contact, ophthalmic lenses not mounted	4,004	8,193	12,343
8841140	Other ophthalmic lenses	16,305	20,086	24,617
8842100	Eyeglasses, etc., frames, mountings, and parts	10,273		
8842120	Eyeglass fronts and temples		3,176	4,883
8842140	Parts, NSPF, for eyeglasses, lorgnettes, goggles, and similar items		7,963	7,244
Total for industry subgroup--Medical supplies		203,216	250,729	321,616
	Industry sector total	1,138,801	1,427,961	1,715,049

SOURCE: U.S. Bureau of the Census, U.S. Exports/Schedule B Commodity by Country, Report FT 446, Annual 1978, 1979, 1980.

companies have not emphasized Middle Eastern sales. As shown in table 81, U.S. exports to Saudia Arabia (the largest Middle Eastern importer of U.S. medical equipment) have been overshadowed by such exports to other parts of the world.

The trend for U.S. exports was upward from 1978 to 1980 in most categories of medical equipment. The exception was Iran where total medical equipment exports from the United States fell 80 percent between 1978 and 1982. Algeria's imports from the United States ($262,000 in 1980) were very limited, most hospital appliances and equipment.[44]

Saudi Arabia and Kuwait have maintained their significant levels of imports of medical equipment, even in the recent period of reduced revenues. The ambitious government hospital construction programs in both countries and the upgrading of some substandard equipment in existing MOH hospitals should boost sales of cardiology equipment, operating room equipment, pediatric equipment, and rehabilitation products. Automated monitoring systems are increasingly being used to counter staff shortages, and a rapid increase in the use of disposables is expected, owing to staff scarcity, high labor costs, mounting awareness of the need for hygiene, and a limited concern over price.

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[44] See United States Department of Commerce, Washington, D.C., *Medical Equipment—Saudi Arabia* (Country Market Survey), CMS 77-022, November 1977, for forecasts of Middle East markets.

Table 81.—Representative U.S. Exports of Medical Instruments, Equipment, and Supplies to Saudi Arabia (value in $000)

SITC Number	Product Description	1978	1979	1980
7741050	Electrocardiographs	40	13	46
7741070	Complete patient monitoring systems	1,514	153	325
7741080	Electro-medical apparatus, NSPF (not specifically provided for)	1,082	2,069	5,832
7741090	Electro-medical apparatus parts	424	748	686
7742030	X-ray apparatus and parts for medical or dental use	1,427	448	826
7742050	Radiological apparatus and parts for medical or dental use	473	31	323
8720405	Ophthalmic instruments and appliances and parts	349	75	646
8720410	Anesthetic apparatus and instruments and parts (except syringes)	221	60	491
8720415	Bougies, catheters, drains, and sondes and parts	724	647	932
8720420	Basal metabolism and blood pressure apparatus and parts	176	172	39
8720425	Hypodermic syringes and parts	143	196	350
8720430	Other syringes and parts, NSPF	196	243	298
8720450	Other medical, etc., instruments and apparatus and parts, NSPF	4,473	4,638	5,345
7416016	Sterilizers and autoclaves and parts	532	408	241
7853020	Wheelchairs and parts	39	221	222
8212100	Other hospital, medical, dental, etc., furniture, NSPF	5,347	5,320	14,980
8720320	Mechano-therapy appliances and massage apparatus and parts	739	1,144	1,172
8720340	Artificial respiration, ozone, oxygen, aerosol therapy, etc.	1,665	1,206	1,978
8996100	Hearing aids and parts, NSPF	84	4	43
8996250	Bone and joint prosthesis, plates, screws, nails, etc.	19	31	27
8996280	Other orthopedic appliances	193	231	893
8720440	Dental hand instruments and parts	210	137	311
8720445	Other dental and instruments, NSPF	397	400	1,792
8996225	Artificial teeth and dentures of plastic	19	17	25
8996240	Other artificial teeth and dentures, NSPF	10	30	97
5419010	Opacifying preparation for radiological examination	6	8	17
5419020	Other diagnostic agents (except biological), NSPF	313	531	837
5419030	Waddings, gauze, dressings, etc. with medicinals	655	475	445
5419040	Other waddings, etc., NSPF	196	363	444
5419050	Surgical sutures and materials, etc., sterile	142	163	378
8482020	Surgical and medical gloves	59	254	222
8720435	Hypodermic needles	15	52	160
8822620	X-ray film, medical, ex dental	858	128	252
8822625	Other X-ray film	56	31	167

SOURCE: U.S. Bureau of the Census, U.S. Exports/Schedule B Commodity by Country, Report FT 446, Annual 1978, 1979, 1980

While countries such as Saudi Arabia and Kuwait have installed the best possible medical equipment in several of their hospitals, countries like Algeria and Egypt have avoided the overly sophisticated equipment and systems that are not considered appropriate for their facilities at this stage. The majority of the existing health care facilities in these two countries operate with much older equipment.

The current situation in Iraq and Iran makes projections on medical equipment market development difficult. Once the war has ended, however, both countries may emerge as strong import markets for medical equipment and supplies.

Major U.S. suppliers of medical equipment in Saudi Arabia are listed in table 82. Major non-U.S. medical equipment suppliers in Saudi Arabia are given in table 83. Health care equipment suppliers and consumers interviewed in the Middle East stated that medical equipment from countries like the United States, West Germany, Sweden, and the Netherlands could generally be considered equal in quality. The United States has for many years been the world's leading supplier of advanced medical equipment, but those interviewed felt that the technological advantage once held by the United States over Europe no longer exists. However, several firms, of which many are U.S. firms, are considered technologically outstanding in their specific fields.[45]

Price has not been a major competitive issue in Saudi Arabia, Kuwait, and prewar Iraq. This is now slowly changing. Price has been one of the most important competitive factors in the other countries, where U.S. exports—especially in the last 2 to 3 years—have been affected negatively due to the strength of the dollar.

A major finding of interviews with industry experts in the Middle East is that service is probably the most important single factor influencing competitiveness in all countries. Service could include delivery, set-ups, testing (when necessary), provision of manuals, provision of spare parts and continuing maintenance or calibration. West Germany is unanimously considered to offer the best services, followed by Japan. U.S. suppliers are generally not considered to put as much emphasis on service as they do on developing new medical technology.

West Germany is the leading supplier of medical equipment to the Middle East, with about 25 percent of the total import market. German companies have combined quality products with an aggressive marketing approach, including excellent after-sales services. West German strongholds are X-ray equipment, electrocardiogram equipment, patient monitoring systems, microsurgery equipment, and microscopes.

The United States is the second largest supplier to this region, with some 18 percent of total imports in 1980. Sales are concentrated in clinical laboratory equipment, electromedical equipment, computerized medical services, disposables, and nearly all types of advanced instrumentation requiring a high degree of accuracy. U.S. products are generally considered competitive in terms of technology, quality, and reliability, but U.S. firms supplying medical equipment are not known for their after-the-sale service.

The United Kingdom, as the third largest supplying nation to this region, had about a 12-percent market share, an almost 50 percent drop from the mid-1970's. The British are still competitive in some product areas like anesthetic equipment, X-ray equipment, and surgical instrumentation. Their lack of competitiveness has been attributed to failure to develop new products in the fastest growing product areas, among other factors.

France ranks as the fourth largest supplier country to this region, with a 10-percent market share, owing mainly to the strong French position in Algeria and Egypt.

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[45] These include: Air Shields (U.S.)—pediatric equipment; Amsco (U.S.)—operating room equipment; Coulter (U.S.)—analyzers; Beckton & Dickerson (U.S.)—disposables; Siemens, (West Germany)--X-ray; Hellige (W.G.)—cardiology equipment; Draeger (W.C.)—anesthetic equipment; and Gambro (Sweden)—dialysis equipment.

Table 82.—Major U.S. Suppliers of Medical Equipment in Saudi Arabia and Relative Market Position

Supplier/equipment	Relative Position
Cardiology equipment	
Hewlett-Packard	Good
Ohio Medical	Good
Air Shields	Marginal
Pulmonary equipment	
Hewlett-Packard	Dominant
Ohio Medical	Good
Renal equipment	
Cordis Dow	Good
Travenol	Marginal
Pediatric equipment	
Air Shields	Dominant
Ohio Medical	Good
Gamco	Marginal
Ivac	Marginal
Ophthalmological equipment	
American Optical	Good
Bausch & Lomb	Good
Welch Allyn	Marginal
General hospital equipment	
American Optical/monitors	Good
Digital Equipment/computers	Good
Hewlett-Packard/monitoring systems	Good
IBM/computers	Good
Kodak/X-ray supplies	Good
Physio Control/X-ray monitoring	Good
Searle Medical/nuclear	Good
General Electric/X-ray, computers	Marginal
Honeywell/computers	Marginal
Picker/nuclear	Marginal
Supplier/equipment	**Relative position**
Operating room equipment	
Amsco/tables, lighting	Dominant
Air Shields/vacuum	Good
American Optical/defibrillators, blood pressure, monitors	Good
Castle/autoclaves, lighting	Good
Ohio Medical/anesthesia	Good
Narco Pilling/instruments	Marginal
Clinical laboratory equipment	
Beckman/automatic analyzers	Dominant
Coulter/blood analysis equipment	Dominant
American Optical/microscopes, pH	Good
Corning/pH	Good
Cutler/solutions	Good
Hewlet-Packard/chromatographs	Good
Bausch & Lomb/microscopes, solutions	Marginal
Chicago Surgical/centrifuges	Marginal
Disposables	
Beckton & Dickenson	Dominant
American Hospital Supply Co.	Good
Ethicon	Good
Johnson & Johnson	Good
Stryker	Good
Kendall	Marginal
Rehabilitation products suppliers	
Birdick/artificial organs, therapy	Good
Franklin/hearing aids	Good
Stryker/therapy equipment	Good
Cordis DOW/artificial organs	Marginal
Metler/diathermy equipment	Marginal

SOURCE: U.S. Department of Commerce, Market Research Division, Medical Equipment Market, Saudi Arabia, 1981.

Japan is quietly but efficiently increasing its market share in every country in the region. Spectrophotometers, X-ray equipment, medical supplies (including disposables), surgical instruments, and a broad range of optical products are some of the Japanese strengths. Japan's 7 percent market share was expected to grow.

Design and Construction of Health Care Facilities

Hospital design in the Middle East is a field where European firms especially British and French—firms have been successful. Some U.S. companies are active in the area, but their activities are limited almost exclusively to Saudi Arabia.

The value of hospital and medical facility construction contracts far exceeds that of equipment imports to the Middle East. The Middle East hospital design market was estimated at $770 million in 1981.[46] As table 31 in chapter 4 shows, construction contracts have been the largest component of medical service exports to the region in recent years.

The design of a hospital in the Middle East requires substantial knowledge of local disease patterns, climatic conditions, social mores, and socioreligious customs. For example, the climatic conditions require special arrangements for ventilation and cooling and protection against damage from sand and dust. In addition, planning must take account of a higher relative share of burns, infectious and parasitic

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[46] No official market magnitude or market share data in hospital design in the Middle East are available. European experts associated with *Middle East Construction* (a monthly U.K. magazine) estimate that the total Middle Eastern hospital design market was valued at about $770 million in 1981, and that the U.S. share was 8 percent, Great Britain, 30 percent, France, 15 percent, Italy, 10 percent, and West Germany, 10 percent.

Table 83.—Major Third-Country Medical Equipment Suppliers in Saudi Arabia

Hellige	West Germany	Cardiology equipment
Zeiss	West Germany	Microscopes
Heine	West Germany	Microsurgery
Siemens	West Germany	X-ray equipment
Draeger	West Germany	Anesthesia equipment
Storz (U.S. subsidiary)	West Germany	Endoscopes
Cambridge	United Kingdom	Electrocardiographs (ECG)
Zimmer Orthopaedic	United Kingdom	Rehabilitative equipment
Downs Surgical	United Kingdom	Surgical instruments
GEC Medical Equipment	United Kingdom	X-ray equipment
Daikyo	Japan	Supplies
Shimadzu	Japan	X-ray equipment
Nagashima	Japan	Surgical instruments
Olympus	Japan	General medical equipment
CGR	France	X-ray equipment
Reichert	Austria	Laboratory equipment
Philips	Netherlands	X-ray equipment

SOURCE: U.S. Department of Commerce, Market Research Division, *Medical Equipment Market, Saudi Arabia*, 1981

Photo credit: Aramco World Magazine

Control room of the King Faisal Specialist Hospital's two-channel closed-circuit television broadcast system serving patients and staff

diseases, and diseases of the digestive system. The facilities must have a high degree of flexibility to keep abreast of constantly changing methods of treatment and teaching. (Part of a newly constructed hospital in Baghdad, is planned to function independently in case of war.) In planning, consideration must be taken of the large number of outpatient treatments and in many countries the limited number of staff, which makes it vital to promptly treat patients. In some of the countries a strict separation of male and female patients is required. In Saudi Arabia separation is required between administrative staff and nurses. In many countries, the waiting room facilities have to be very spacious in order to make room for the rest of the family and accompanying relatives and to use these facilities for demonstrations and teaching activities. Also, separate waiting rooms for males and females must often be provided.[47]

One example of U.S. participation in hospital design and planning is the $2 billion medical city project on the site of Jeddah's old international airport, where the proposed complex will comprise an 800-bed hospital and colleges of dentistry, pharmacology, and other medical sciences. Henningson, Durham and Richardson Architects have the design subcontract and Daniel International of Saudi Arabia, a subsidiary of the Fluor Corp. (U.S.), has the overall coordination responsibility. The hospital will be constructed according to U.S. standard specifications, but every attempt is being made in the design to adapt it to the local cultural environment. Special manuals both in English and Arabic have already been prepared to brief staff and project members on local requirements. The programming element prior to the detailed design is the most expensive and specialized part of the project, and U.S. health care consultants are used for advice on special facility needs.

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[47] Interview with officials of Henningson, Durham and Richardson Architects, Louisiana.

In the market for turnkey hospital construction, experienced Western contractors—primarily German and French—still have a competitive edge. Philip Holzmann of Germany is the leading hospital turnkey contractor, with seven completed projects totalling 3,400 beds in the area in the last 5 years. The major part of the Middle Eastern hospital contracting market is currently shared between West Germany, France, South Korea, Italy, and a growing number of local contractors in joint venture with foreign companies. Up until 1981, South Korean firms, so successful in other Middle Eastern infrastructure projects, were not invited to bid as general contractors on the Saudi hospital projects. This is now changing rapidly, and in 1982 South Korean firms were successful or low bidders on nine hospital projects in Saudi Arabia, Iraq, and Kuwait.

The respective governments' desire to increase the local share of public construction work is clear also in the health care sector. In Saudi Arabia, some of the local contractors in joint ventures, mainly with French and British firms, have been successful in winning contracts over foreign competitors. Two examples are Beta Construction and El Seif Engineering and Construction, locally owned Saudi contractors that have been approved to pre-qualify for the Health Ministry hospital program. In the last 2 years, the successful European companies have formed joint ventures to bid and carry out hospital contracting work. Joint venture arrangements will be used increasingly in the health care contracting field in order to secure government contracts. In Saudi Arabia, the Government has stated its intention to award the majority of contracts to Saudi companies.

U.S. companies are not active in the Middle Eastern hospital construction market. Only three U.S. firms are included in the list of over 40 contractors bidding for MOH projects in Saudi Arabia, and very few major hospital construction contracts have been awarded to U.S. companies in the Middle East since 1980. Observers cite a number of factors as reasons:

- The dominance of turnkey hospital contracting in Saudi Arabia, the largest and most lucrative market, where European contractors—especially German, French and Italian—have established themselves as leaders.
- The nonexistence of U.S. companies in the market specializing in hospital contracting work.
- The declining competitiveness of U.S. contracting services, partly due to the increased competition from European and Asian rivals, and the value of the dollar, which is reflected in lower bids by other contractors.[48]
- The so-called disincentives for U.S. exporters in general, which mainly concern the overseas tax situation, and the laws on antitrust, antiboycott, and anticorruption activities.[49] Although being disincentives to U.S. companies, these do not appear to be as major a factor as the three factors listed above.

Hospital Management

Saudi Arabia is by all accounts the greatest importer of hospital management services, although management contracts have also been awarded in the UAE, Egypt, and North Yemen.[50] Whittaker Corp. has ongoing negotiations with Iraq's MOH for a management contract in Baghdad, which if it materializes, will be the first of its kind in that country. Outside of Saudi Arabia and except for other scant examples, the predominant policy of the governments has generally been to administer the health care facilities themselves, and in case of foreign manpower needs, to establish health accords on a bilateral basis with foreign governments. Thus, in other parts of the region imports of other types of technical services (training, operation and maintenance, etc.) are the major types of imports, in addition to construction services. As shown in table 31, these service imports represent a large share of medical service sector imports.

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[48] For every $1.25 bid by a Far East contractor, the U.S. firms will, on the average, bid $1.70—a 37 percent variance. *Middle East Economic Digest*, quoting a U.S. Department of Commerce representative; *U.S.-Arab Trade*, October 1982.

[49] USITC publication (September 1982) "The Relationship of Exports in Selected U.S. Service Industries to U.S. Merchandise Exports," pp. 246-247, gives three examples: 1) even in countries where U.S. health management companies are currently active, such as in Saudi Arabia, the Foreign Corrupt Practices Act was cited by a health care management company as being a major reason why the company failed to obtain more contracts; 2) U.S. antiboycott laws were also cited by several companies as constituting a barrier against foreign trade expansion; 3) U.S. antitrust laws were cited by some health industry representatives as inhibiting foreign trade expansion.

[50] Ibid, p. 257. The report states that U.S. hospital management firms held about 70 percent of the contracts awarded in Saudi Arabia in 1981, with the total Saudi hospital management market worth more than $500 million.

HCA a strong presence in the Middle East since assuming management of the very modern King Faisal Specialist Hospital and Research Center in Riyadh when this complex opened in 1975. HCA is also managing the hospital at Al Batin, the King Khaled Military City. In 1982 HCA's local subsidiary, HCA Saudi Arabia, won the much sought-after contract for operation, maintenance, and management of the 500-bed Saudi Arabian National Guard (SANG) hospital complex in Riyadh.

Whittaker Corp. signed the first contract with Saudi Arabia in 1974 for management of MODA's three military hospitals at Jeddah, Tabuk, and Khamis Mushayt. This contract has been extended three times. Two more hospitals and a number of clinics have also been added, bringing Whittaker's current staff in the Kingdom to about 3,000. The corporation's emphasis is on basic medical and surgical treatment, including some preventive medicine and public health services. The recent decision of the Saudi Arabian Government to open these contracts to competitive bidding led to a shift in the firm's position.[51] Whittaker also has two management contracts in neighboring countries—for a 535-bed hospital in the UAE and a hospital in North Yemen (financed by Saudi Arabia).

National Medical Enterprises (NME) manages the 318-bed Al-Hada hospital in Taif for MODA; the 105-bed acute care hospital at King Abdul Aziz Airbase in Dhahran, also for MODA; and the 120-bed Public Security hospital in Riyadh. NME also has contracts to equip seven MOH hospitals, ranging from 50 to 300 beds, under construction throughout the Kingdom.

AMI is the only U.S. hospital management company that runs a MOH facility, the 355-bed general hospital at Al-Baha. AMI Saudi Arabia Ltd. has also signed a contract with the Ministry of Finance and National Economy for the full operation of a 263-bed specialist eye hospital in Riyadh, which will function as a leading referral center in the country for the treatment of eye disorders.

Other U.S. health care management firms in Saudi Arabia that have substantially smaller operations, mostly in the private sector, are Charter Medical, American Health Facilities International, International Medical Services, University Association for International Health, and Herman Smith Associates, International.

Based on the experience of U.S. firms contacted primarily in Saudi Arabia, factors affecting competitiveness on individual contract awards for hospital management are summarized below.[52]

- performance track record and longevity of firm,
- effective use of local agent or joint venture relationship,
- political support of bidding government,
- prior experience and reputation in the Middle East,
- price,

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[51] See *The Wall Street Journal*, November 1983 and Michael Petrie-Ritchie, Allied Medical Group (AMG) Re-enters Saudi Medical Scene," *Middle East Economic Digest*, March 16, 1984, p. 37. Whittaker—the present management contactor for the three MODA hospitals at Jeddah, Khamis Mushayt and Tabuk—was the highest bidder for the new three-year management contract at $1,114.7 million when the bids were opened on March 11, 1984. The lowest of the nine bidders, at $571.5 million, was the U.K.'s Allied Medical Group (AMG) which teamed with the local El-Seif Development Establishment. The project was split into three packages. with AMG/El-Seif winning management contracts for two hospitals; a U.S.-Saudi joint venture (Fairview) won the other hospital management contract. See *Middle East Economic Digest Special Report—Saudi Arabia*, July 1984, p. 89.

[52] Those firms include Whittaker, HCA, and AMI.

- responsiveness to the request for proposal and tender specifications, and
- involvement of individuals from the higher echelons of the corporation.

U.S. firms have had an advantage over those of other countries because of the perceived superiority (especially in Saudi Arabia) of U.S medicine. For sophisticated medical care, Middle Eastern countries have consistently looked to the United States. This technical advantage applies not only to medical practices but also to hospital administration. The major U.S. firms have established reputations for efficient, cost-effective hospital management, and expect the demand for such services to grow in countries such as Egypt and the Gulf States.[53]

British firms are the major competitors in Middle East hospital management. The major British health care management firm is the Allied Medical Group. It is 70-percent owned by the British government through the National Enterprise Board and has the management contract for two MODA hospitals. The other major British health care management company is the International Hospitals Group (IHG), which is a consortium of health care companies organized on an ad hoc, project-by-project basis. The major IHG involvement in Saudi Arabia is the contract for managing the 500-bed SANG hospital in Jeddah. This contract was arranged through direct government-to-government negotiations.

In addition, countries like Denmark, Sweden, West Germany, and Taiwan have concluded agreements for management work in Saudi Arabia. In contrast to the U.S. and British contracts, which have been signed primarily with non-MOH agencies, the MOH has signed health agreements with the respective health ministry of each country concerned, thereby meeting its manpower needs through bilateral agreements rather than through private health care management contracts.

The management firms are also beginning to face increased competition from firms organized within the host countries. In Saudi Arabia, a 100-percent Saudi company has been formed which hires Westerners to staff and manage hospitals. U.S. health care management firms have prepared for the inevitable increased local involvement in Saudi Arabia by opening partially Saudi-owned subsidiaries or by organizing joint ventures.

Selected medical services contracts in Saudi Arabia, Egypt, Algeria, and Iraq are shown in appendix A, tables A1 through A4. These are not all-inclusive lists, but show the diversity in types of projects and costs, foreign involvement, and ownership structure.

U.S. firms will undoubtedly remain major suppliers of hospital management services in the Middle East. Recent experience in Saudi Arabia indicates that willingness to work with local companies and marketing will be increasingly important aspects of contract awards.

FACTORS INFLUENCING COMMERCIAL TECHNOLOGY TRANSFER IN THE MEDICAL SECTOR

Controls Regarding Medical Exports

U.S. manufacturers of medical equipment must comply with the reliability and efficiency regulations issued by the Bureau of Medical Devices of the U.S. Food and Drug Administration (FDA).[54] Some exporters say that controls on exports of some high-technology items involving computers and microprocessors have limited some medical equipment exports. Array processors, sometimes used in computerized tomographic (CT) scanners, are, for example, subject to export controls. There have been no cases where these regulations clearly constituted a disadvantage to U.S. firms in the Middle East region which OTA was able to document. But as medical technology becomes increasingly sophisticated, concerns may grow if export controls are extended to cover many types of medical equipment involving optical equipment, electronic equipment, and computer hardware and software.

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[53] *Middle East Economic Digest*, "Health Contracts Test U.S. Responses," *U.S.-Arab Trade*, October 1982, p. 24. See also Michael Petrie-Ritchie, "Saudi Arabia's Healthcare Market—The Prognosis is Good," *Middle East Economic Digest*, November 1983, p. 38.

[54] OTA's forthcoming report on "Federal Policies and the Medical Devices Industry" will include review of various regulations affecting medical devices sales.

Financing

In the Gulf States, supplier financing has been a minor ingredient in awards of contracts for health care projects. Saudi Arabia, Kuwait, the smaller Gulf States, prerevolutionary Iran and prewar Iraq have all been capable of providing financing and other factors such as quality, serviceability, speed, manpower, and training have been more important in contract decisions.

In Algeria and Egypt, foreign companies engaged in health care projects are required to conform to certain principles, including regulations concerning foreign exchange. The U.S. Export-Import Bank has supported exports to Algeria, but few in the medical equipment or hospital construction sector. French and Belgian firms, in contrast, have financed two Algerian hospital projects with government-backed soft loans.

In Egypt, financing arrangements strongly influence the competitive positions of suppliers. Many Western supplier countries have established government-to-government agreements with Egypt in the health care field in recent years. Under these agreements, large hospital projects have been undertaken by French, Belgian and Japanese firms with financing provided by respective supplier governments. There is no doubt that financing will continue to be of critical importance in determining the award of health care infrastructure contracts in Egypt and Algeria, and also in Iraq, if and when a resolution of the Iran-Iraq conflict occurs. Beginning in 1983, some Gulf countries also began to consider external financing for their planned health care projects.

Other Types of Foreign Government Involvement

There is a growing trend of bilateral agreements and health care accords in the region. Some bilateral health care cooperation projects in the region include:

1. **Saudi Arabia-Taiwan.** Signed in Riyadh in February 1983 with the following components: a) exchange of medical experts, b) training of Saudi Arabian students in the medical field, and c) administration and operation of King Fahd Hospital in Hoful and King Fahd Hospital in Jeddah, and furnishing of physicians, nurses, and supporting staff for the two hospitals.[55]
2. **Kuwait-Sweden.** Signed in Stockholm in October, 1981 with the following key provisions: a) Sweden to provide some 60 physicians and 40 senior technicians in 1982/83, b) exchange of expertise and further training of doctors who are practicing in Kuwaiti hospitals, and c) cooperation—mainly on curricula and training methods—between Kuwait Medical School and the Karoliaska Institute in Stockholm.[56]
3. **Egypt-United Kingdom.** Signed in Cairo in 1980, covering the following main fields of medical expertise exchange: a) pharmaceutical control experts, b) TB-screening experts, c) cancer diagnostic experts, and d) maternal and child health center experts.[57]
4. **Egypt-Belgium.** Signed in Cairo on two occasions, in 1976 and in 1982, with some of the key areas of cooperation being: a) emergency facilities and procedures, b) pharmaceutical quality control, c) environmental medicine, d) dentistry, e) nursing, f) tropical medicine research, and g) research in pesticides and parasites.[58]

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[55] *Arab News*, Saudi Arabia, Feb. 21, 1983.
[56] *Arab Times*, Kuwait, October 1981.
[57] British Overseas Trade Board, U.K.: Egypt, 1981.
[58] Ibid. *Middle East Economic Digest*, Aug. 13, 1982.

5. **Egypt-Japan.** An agreement involving cooperation in health care infrastructure development. The only project so far consists of a Japanese grant for construction of a pediatric hospital at Cairo University.[59]
6. **Kuwait-United States.** The U.S. Department of Health and Human Services is providing technical assistance in health to Kuwait's Ministry of Public Health under a Memorandum of Understanding signed in 1981. Technical assistance is provided for five projects: a) emergency medical services; b) hypertension control; c) reduction of infant morbidity and mortality; d) health manpower development and utilization; and e) vital and health statistics.[60]

Some U.S. health care firms with experience in the highly competitive Middle Eastern region claim that these bilateral agreements provide entrees for foreign firms, since purchases of health care goods and services in these projects generally are made from firms in the donor country.[61] The United States is involved in bilateral health agreements in the Middle East and AID programs provide commercial opportunities to U.S. and developing country suppliers of medical equipment and services.[62] Supplier countries like France, Great Britain, West Germany, and Japan have been said to use cooperation in the health care field in the Middle East in a systematic way to support their respective commercial interests in areas such as hospital construction which are not central to AID program. In all cases, however, economic assistance programs in the health area provide commercial opportunities to donor country firms.

U.S. health care suppliers sometimes claim that foreign firms involved in health care service exports to the Middle East are strongly assisted by the formal and informal sponsoring of their governments. When the International Hospitals Group of Great Britain was awarded the management contract for the Saudi Arabian National Guard 500-bed hospital in Jeddah, negotiations were reportedly handled by the British Ministry of Defense, supported by the Department of Health and Social Security. A visit by Prime Minister Margaret Thatcher to Saudi Arabia helped bring the negotiations to a close. During negotiations for health care contracts, especially in the Gulf countries, the foreign firm or consortium may be represented by a prestigious government official.

The U.S. Foreign Commercial Service provides routine representation of U.S. firms and has activities designed to assist trade promotion missions in the medical services field.[63] Nevertheless, U.S. health care exporters to the region argue that support provided by the government, through official U.S. commercial representation in the area, is not comparable to that of some other Western nations. The British, West German, and Scandinavian commercial representatives are said to maintain extensive direct contact with business at home and actively pursue and create business opportunities in the Middle East.[64] Data are not available that would allow for comparison of the dollar value of allocations for trade promotion in this area, but it does appear that in many cases non-U.S. suppliers recruit high-quality personnel to work in official trade promotion activities.

U.S.-Imposed Trade "Disincentives"

U.S. suppliers cite the FCPA and antiboycott regulations as barriers to foreign trade expansion because foreign competitors are not subject to equivalent regulations. As discussed in chapter 13, together such regulations present a disincentive for exporters to some degree, but OTA was not able to document specific cases where contracts were lost because of them.

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[59] U.S. Embassy, Cairo, February 1983.

[60] *Science, Technology, and American Diplomacy—1983*, Fourth Annual Report Submitted to the Congress by the President, Washington, D.C., September 1983.

[61] The health care accord reached between Egypt and Japan (number 5 in the list of bilateral health care cooperation projects) states that Japanese equipment should be used. In the agreements reached between Egypt and Algeria, on the one hand, and France, Belgium, and the United Kingdom, on the other, it is not stipulated that design, construction, and equipping of health facilities should be monopolized by the assisting country. But, according to the U.S. Embassy in Cairo and the British Overseas Trade Board, Great Britain, the services and equipment in the facilities come almost exclusively from the assisting country.

[62] AID activities in Egypt have certainly provided commercial opportunities for U.S. firms, particularly through the Commodity Import Program.

[63] U.S. Department of Commerce, March 1984.

[64] Based on interviews held with U.S. health care exporters in 1983.

FUTURE PROSPECTS

This section discusses the potential political and social effects of medical technology transfer to the Middle East. U.S. policy options are also identified.

POTENTIAL POLITICAL AND SOCIAL DIMENSIONS OF HEALTH CARE

Developments in the health care sector contribute indirectly to social and political changes in recipient countries. While it is impossible to anticipate all the effects of health care development, it is important to identify several types of potential effects.

Increased Health Care Expectations

During the last decade, the expectations for improved health care have risen as allocations to the sector have been increased. As a result, health standards have improved and the effects on local living conditions have been generally stabilizing and beneficial. Public health education programs have also made people more aware of the potential benefits of health care. One potential problem could occur if a fall in oil revenues were to lead to a severe cutback in allocations to the health care sector up to present, however, most of these countries have attempted to maintain their social investments.[65]

Integration of the Health Care System into the Culture

Grassroots involvement is important to properly integrating health care into the society. For example, where the effort toward curative facilities is unmatched by an equivalent effort in preventive medicine, dissatisfaction may arise. This will be particularly evident when there is a lack of local involvement which results in the perception that health care is being "imposed" and not "integrated" into the cultural system, or that it is manned or managed exclusively by expatriates.

Role of Women

The future role of women in the work force is a crucial issue in some Middle Eastern countries. In light of the significant labor shortages in Saudi Arabia, the medical sector could be promising area to bring more women into the productive workforce. But so far, signifcant social barriers remain. In Algeria, Iraq, and pre-revolutionary Iran, on the other hand, change in this area has been more rapid.[66]

Staffing

Plans already under way call for major expansions in staffing. Much of this expansion, it would appear at this time, cannot be met from the countries' internal resources. This means that in the medium-to-long term, expatriates will be required. If qualified personnel cannot be recruited, standards may fall and facilities may not be effectively utilized. Underutilization of facilities due to staff shortages has indeed already occurred in Saudi Arabia.

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[65] *Financial Times*. Apr. 26, 1982; Apr. 14, 1983. Human resources and labor development remained high priorities in the Saudi budget. The decline in allocations to health programs was about 20 percent in 1983-84 over the 1982-83 budget. See Edmund O'Sullivan, "Spending Squeeze Continues in 1983/84," *Middle East Economic Digest*, Apr. 15, 1983, p. 54. Total state spending in 1984-85 was projected to increase, however, by $12 billion from the 1983-84 levels. The Ministry of Health was one of the few ministries to receive increased allocations in the 1984-85 Saudi budget. (See Michael Field and Finn Barre, "Saudi Arabia Boosts spending to $75 billion," *Financial Times*, Apr. 2, 1984, p. 1.)

[66] One indicator of the role of women is the number of females working in the medical sector in each country.

1. In Iran, of the total number of physicians in 1968, 7 percent were females. The first year of medical school sample contained 24 percent females, whereas the final year students' group had 10 percent females. There was an accelerating trend in the acceptance of female medical students in Iran in the 1960's. (A. Torab-Mehra "Orientation of Iranian Physicians," Iran Foundation, 1969.) In 1978, 25 percent of the medical students in Iran were female. Of an estimated 21,000 nurses in Iran in 1978, 82 percent were Iranian, and of these, over 90 percent were female. ("A Health Care Revolution," *Middle East Health Magazine*, October 1982.)
2. Out of 354 medical students in Iraq in 1976, 21 percent were female. Out of 4,500 nurses in 1976, an estimated 65 percent were Iraqi, and of these over 70 percent were female. (U.S. Department of Health, Education, and Welfare: Iraq Health Sector, 1977.)
3. The total number of nurses in Algeria rose from 2,400 in 1972 to over 9,000 in 1978, and over 90 percent were Algerian women. (World Bank, "Algeria—The Five-Year Development Plan," 1982.)

Unless the number of technicians increases drastically, much of the equipment installed over the last decade may not be used properly. There are hopeful signs that the importance of maintenance is increasingly recognized, but it is unlikely that maintenance needs can be met from local resources for some time to come. Expatriates will remain critical in the intermediate phase, particularly to Saudi Arabia and Kuwait. In Egypt, future manpower development activities are expected to concentrate on improving the quality of education in all staff categories, expanding opportunities for continuing education, incentives to reduce the multiple employment (most government physicians also run a private practice), and increasing general management capabilities. Key areas for future transfers of technology in the manpower field will be foreign assistance in public health training, postgraduate education and training of biomedical engineers, and training of medical equipment maintenance engineers and technicians.

In the past, Middle Eastern countries have taken widely differing approaches in their selection of medical technologies and delivery systems. Countries like Saudi Arabia have worked to expand medical facilities that include extremely sophisticated and costly medical technologies; Egypt and Algeria, with larger populations and more limited resources, have placed more emphasis on community health programs involving simple technologies.

In the future, however, the most pressing need throughout the region will continue to be for less sophisticated medical technologies, used in preventive medicine. Even in the richer Gulf States, providing such health care to remote rural locations will remain imperative, if the benefits of medical technology transfers are to be spread more equally throughout society. Generally speaking, U.S. firms have not been major independent suppliers of less sophisticated medical equipment or staffing and servicing of small-scale clinics, outside their involvement through AID programs. AID programs in the health sector will thus remain critical to meeting the most pressing basic requirements for medical services in the developing countries of the Middle East.

IMPLICATIONS FOR U.S. POLICY

Export Promotion/Export Regulation

In the Gulf countries, financing has been a minor determinant in the process of awarding contracts in the health care sector. It has become more important, however, for war torn Iran and Iraq, as well as other Gulf States whose revenues fell below expected levels during the oil glut. In countries like Egypt and Algeria, it will continue to be of decisive importance. Therefore, supplier government financing support may become an increasingly important influence on competition among suppliers. U.S. policymakers may wish to consider policy options to improve financing of medical equipment and services through the Export-Import Bank and through programs involving investment guarantees provided by the Overseas Private Investment Corp. One approach would be to extend international agreements among suppliers to reduce the use of mixed credits and tied aid; another would be to adopt such programs because our competitors have them. These issues are discussed more fully in chapter 11.

A different type of approach is to improve capacity of the U.S. foreign commercial service to provide assistance to firms interested not only in exporting medical equipment, but also in transferring technology through training and other specialized programs. Bilateral agreements to promote cooperation between the United States and Middle East nations in medical science and technology could be extended to facilitate such efforts.

Development Assistance and Foreign Policy Issues

One approach which could be considered would be to expand U.S. participation in multilateral assistance programs, such as those of the United Nations. EMRO promotes technical cooperation between the countries in the area in order to reduce the dependence on imported expertise and to enhance their self-reliance through training and research. The impact of EMRO's work has been limited, however, by political disagreements, restricted financing (with an annual budget of about $20 million to cover activities in 22 countries), and differences in health care policy issues across the countries of the region. EMRO is promoting the use of intermediate level medical technology and is striving to limit the use of imported manpower, whereas the Gulf States emphasize the acquisition and use of a broad spectrum of medical technology and have accepted foreign personnel as a temporary solution to their manpower needs.

U.S. health care development assistance to the region is today concentrated in Egypt. U.S. projects focus on delivery of medicine and health care at the community level rather than larger infrastructure projects. For example, hospital construction is not a U.S.-assisted priority area, mainly because the cost-effectiveness of such ventures is considered to be low in view of Egypt's basic health needs. U.S. health assistance is apparently perceived as generally effective by both Egyptians and Americans. One of the reasons for this is cooperation between the respective U.S. organization and MOH in choosing the projects to be sponsored. MOH also cosponsors each project financially with at least 25 percent of the total cost. Another explanation is the high caliber of U.S. staff employed and otherwise engaged in the projects. Projects often stand or fall depending on the ability and commitment of the local counterpart, and local participation has contributed to successful projects.

Nevertheless, policymakers may wish to further direct AID policies in order to meet varying goals. One approach would be to expand commercial opportunities for U.S. firms through use of mixed credit and continuing procurement policies favoring U.S. firms. Another approach would be to emphasize more strongly programs which promote technology transfers in specialized areas such as upgrading health manpower, establishing centers of medical research excellence, and improving servicing and maintenance of medical equipment. AID is now studying ways to improve its science and technology programs in Egypt, and this effort can be expected to sharpen the focus of S&T programs in the medical field. OTA's research indicates the important role played by nongovernmental organizations such as Project HOPE; expanded government support for such programs could also be considered.

Health care has been a foundation for U.S. assistance programs and will undoubtedly remain a priority area for AID. As overall U.S. economic assistance to Egypt increases, one question will be whether to promote programs involving medical technology transfers (which require considerable personnel and comparatively long time periods for completion), or rather to stress the expansion of commodity import and other programs supporting imports of medical equipment. OTA's research indicates that there is a clear need for specialized programs designed to upgrade the quality of medical manpower throughout the region, and that aid programs serve to meet needs for medical services and training that would probably not otherwise be filled independently by private U.S. firms.

CHAPTER 9

Nuclear Technology Transfers

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CHAPTER 9

Nuclear Technology Transfers

INTRODUCTION

Nuclear technology transfers are different from the other technology transfers examined by OTA because some nuclear technologies can be used to supply the materials necessary to construct nuclear weapons. Since the 1950's, when it first began to be developed for peaceful purposes, nuclear technology has become the epitome of "dual use" technologies—those that have both civilian and military applications.

On the one hand, developing nations—particularly those not well endowed with oil and other natural energy resources—see in commercial nuclear power a way to meet their rapidly growing demand for electricity. In addition, many developing countries view nuclear research as a means to build their national technical and scientific infrastructures. On the other hand, because of their potential weapons applications, some nuclear technology transfers raise critical military and foreign policy questions. Nuclear technology transfers to the Middle East, a region that has experienced major wars and changes of regime, as well as growing oil revenues during the last decade, thus raise important technological, commercial, and strategic questions for countries in the region. Nuclear technology transfers to the Middle East are also of central importance to U.S. nuclear nonproliferation policies.

In contrast to the other technology transfer sectors examined in this report, commercial nuclear power is currently at a very early stage of development in the Middle East. Nevertheless, decisions taken now about nuclear technology transfers can directly affect the political, military, and economic future of the region. There is today no commercial nuclear facility in operation in the region, but there are a number of nuclear research facilities, and a few nations have plans for commercial nuclear power development. The Islamic countries of the Middle East[1] have widely differing plans for nuclear technology. Before its revolution, Iran had the most extensive plans for such development. In Egypt the rationale for commercial nuclear power is comparatively strong, and planning for a commercial program is under way. Saudi Arabia and Kuwait have not committed themselves to nuclear power. Libya has clearly expressed an interest in nuclear weapons applications, as well as nuclear power.

OTA's analysis indicates that no Islamic country in the region will be capable of acquiring a nuclear explosive device on a wholly indigenous basis within this decade, and most would find it impossible to do so before the turn of the century. Egypt has the strongest technical infrastructure, but would not be able to produce nuclear weapons independently before the late 1990's. With assistance from foreign scientists and engineers and suppliers of critical items, however, these constraints posed by weak indigneous technical infrastructures could be reduced or eliminated, depending on the extent and type of assistance.

While it is unlikely that any of these nations will acquire large enrichment and reprocessing facilities that could supply very large, dedicated weapons programs,[2] smaller-scale nuclear technology transfers (involving research reactors and laboratory-scale sensitive facilities) are expected to increase. These small-scale sensitive facilities are required for peaceful research, but they can also be used (albeit with difficulty) for production of nuclear weapons materials. Therefore, the prospects for nuclear weapons proliferation in the Middle East will increase in the years ahead as these facilities are introduced, as new supplier nations not parties to the Nonproliferation Treaty (NPT) enter the market, and as Middle Eastern countries improve their technical capabilities.

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[1] This report deals with the countries of the Islamic Middle East. Because Israel has attained a much higher level of technological development, it is not included as a major focus of study. However, Israel's nuclear capabilities are discussed in this chapter as necessary for an understanding of nuclear technology transfers to the region. The term "Islamic countries" is used here simply to indicate that sizable proportions of the populations of these countries are Muslims, or followers of Islam. As discussed in ch. 3, there are many groups in these countries and the role of Islam in political, economic, and social affairs varies widely.

[2] Enrichment and reprocessing technologies are referred to as "sensitive" technologies because of their applicability to weapons programs.

During the next decade a number of Middle Eastern countries could begin operation of commercial power reactors. By themselves power reactors do not pose a significant direct proliferation risk.[3] It is technically impossible to use a light-water power reactor (LWR) or a Canadian Deuterium Reactor (CANDU) to produce plutonium for a nuclear explosive without access to enrichment in the case of LWRs, and to reprocessing for both.

Despite the contribution that nuclear power could make to meeting anticipated rapid growth in the demand for electricity, a number of factors limit the attraction of nuclear power to many Middle Eastern nations. These include the high costs of nuclear plants, limited interconnected grids, and the availability of hydrocarbon and other energy sources, including solar energy. Of all the Middle Eastern countries, Egypt has the most extensive current plans for commercial nuclear power but will be able to acquire reactors only with subsidized foreign financing.

This chapter describes the constraints and opportunities for nuclear technology transfers to the Middle East, paying special attention to both commercial and military applications, and identifies the implications for U.S. policy. The issues discussed are of particular concern because the spread of nuclear weapons in the Middle East would not only threaten the national survival of Middle Eastern countries but also substantially reduce the ability of the United States to influence events there.

In addition to the six nations of primary consideration in the report, this chapter deals peripherally with a number of other countries that must be considered in an analysis of nuclear technology transfers to the Middle East. One goal is to identify major factors recipients must consider as they make choices about nuclear technology transfers; another is to clarify trends important for U.S. policies in the years ahead.

NUCLEAR FACILITIES IN THE MIDDLE EAST

Developing countries account for only a minor part of commercial nuclear capacity worldwide. At the end of 1980, there were 256 nuclear power reactors operating around the world, with an installed capacity of 136 gigawatts electric (GWe), or about 7 percent of installed world electrical generation capacity. About 98 percent of this capacity was located in the Organization for Economic Cooperation and Development (OECD) nations,[4] and the Soviet Union and Eastern Europe.

For nuclear power or nuclear weapons, certain types of nuclear technologies, fuel or material, technically trained manpower, systems for delivering either electricity or weapons, and political commitments are necessary. The requirements are different for commercial power production and weapons production, but some facilities can be used for both. The discussion that follows briefly identifies various types of nuclear technologies that have been or may be transferred to Middle Eastern nations, and then evaluates their significance for both commercial power and weapons programs.

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[3] The risk of a nation's using either fuel or spent fuel from such power reactors in the production of nuclear weapons is minimal when safeguards are effectively enforced, and nonexistent when no sensitive facilities (open or clandestine) are present. However, it is technically possible to support a significant nuclear weapons program by using a reprocessing facility of moderate size to reprocess spent fuel from the power reactor. In the case of a safeguarded power reactor, spent fuel would have to be diverted to a clandestine reprocessing facility or utilized in a reprocessing facility acquired for the ostensible purpose of peaceful research.

[4] OECD nations include the United States, Japan, Australia, New Zealand, and major West European nations.

COMMERCIAL NUCLEAR POWER REACTORS

Commercial power facilities include a number of reactor types currently in operation, such as LWRs, including pressurized water and boiling water types, and CANDU. Most of these reactors were developed for use in industrial nations and are comparatively large scale, or more than 600 MWe in capacity.

Iran and Egypt: Countries With Current or Previous Nuclear Power Plans

Most of the major countries in the region have at some point studied the feasibility of nuclear power for generation of electricity and desalination. Iran under the Shah developed the most ambitious program for nuclear power development of any of the Middle Eastern countries. Iran's program, which came to a halt after the revolution, called for building 23 reactors in 20 years to generate 23,000 megawatts of electricity (MWe) by 1994.[5]

Iran carried out negotiations with a number of suppliers during the 1970's, and the West German firm Kraftwerk Union began construction of two 1,300-MWe pressurized light-water reactors near Bushehr on the Persian Gulf. When work stopped on these reactors in late 1978 with the mass exit of German technicians during a nationwide Iranian labor strike, the two reactors were 75 percent and 65 percent complete. In the past year, some official Iranian spokesmen have indicated interest in a renewed nuclear program, but construction has not been resumed on the two reactors, although a feasibility study was under way in May 1984.[6]

Egypt today has more extensive plans for commercial nuclear power development than any other Middle Eastern country under study. By 2000, its official plan is to have 8 reactors in operation, with a total generation capacity of 8,000 MWe, amounting to 40 percent of its electricity. However, Egypt's nuclear plans have been quite volatile over the years, with activity in the mid-1960's, followed by inactivity until 1973-76, followed by more delay. The Egyptian program is stimulated by insufficient alternative power sources and a comparatively large nuclear manpower pool, but owing primarily to financing problems, construction has not begun on any of these reactors. Negotiations with France progressed to an advanced stage, and that nation signed preliminary agreements to supply two 950-MWe turnkey reactors to be located at El Daba'a, northwest of Cairo. French spokesmen continue to state that final agreements are imminent and that the reactors will go online in the early 1990's.[7]

Egypt selected the Swiss firm Motor Columbus to work on an 18-month contract as the consulting engineer for the first two reactors and to help prepare the tenders for the bids for the second two reactors. In early 1983 the Egyptian Government called for bids on four reactor units, and by the end of the year the French firm Framatome, the West German firm Kraftwerk Union, and U.S. firms Westinghouse and Bechtel had submitted bids.[8] Thus, negotiations continue with firms from various nations for supply of reactors, but Egypt has reached no firm agreements, and technical assessment of the bids continues.

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[5] Daniel Poneman, *Nuclear Power in the Developing World* (London: Allen and Unwin, 1982); Bihan Mossavar-Rahmani, *Energy Policy in Iran* (New York: Pergamon Press, 1981), p. 105.

[6] Kraftwerk Union and the Atomic Energy Organization of Iran signed a contract under which Kraftwerk Union will carry out an inspection of the Bushehr site in order to determine the feasibility of completing one of the reactors; the same report claims that site maintenance has been good. See "Kraftwerk Inspects Nuclear Plant," *Middle East Economic Digest*, Dec. 9, 1983, p. 12. See also "Official Comments on Iranian Nuclear Research," *Iranian News Agency*, Mar. 16, 1982. Kraftwerk Union spokesmen confirmed that 40 engineers were carrying out a feasibility study on site in May 1984.

[7] "According to the Current Timetable, Egypt and France Should Come to Terms," *Nucleonics Week*, June 10, 1982, p. 7; "In Brief," *Middle East Economic Digest*, vol. 26, No. 51, 1982.

Middle Eastern Countries Considering Nuclear Power

A number of other Middle Eastern countries have shown interest in developing commercial nuclear power, but none of them is as far along as Egypt. Libya has plans to acquire four nuclear reactors by 2000 and is negotiating with the Soviet Union to purchase a 440-MWe reactor from the Soviet export organization Atomenergoexport.[9]

The Syrian government has plans for two to six reactors, but has done little to carry out these plans. In 1981 the Minister of Electricity announced that feasibility studies had been initiated. The French firm Sofratome was selected to carry out a feasibility study in the summer of 1982, but the study was delayed through the end of that year. Discussion in Syria has focused on two power reactors, each with a capacity of 660 MWe.[10] Iraq has expressed interest in a commercial nuclear program, and at the Second Arab Energy Conference in 1982, it was forecast that Iraq will have an installed capacity of 1,400 MWe by 2000. Negotiations with France for the purchase of a 900-MWe pressurized-water reactor were mentioned.[11] More recently, it was reported that the Iraqi nuclear energy organization signed an agreement with the Soviet firm Atomenergoeksport to carry out the first phase of a study to choose a site for a nuclear power station.[12]

Algeria has made no firm commitment to nuclear power development, but government planning organizations have considered nuclear power in medium- to long-term development plans. In 1976, for example, a special decree was issued which called for establishment of nuclear reactors as a stimulus to industrial development.[13] Similarly, Kuwait has no formal plans for a nuclear power program, but a number of feasibility studies have been carried out, some regarding use of nuclear reactors in desalination. More recently, the Kuwaiti Government discussed the possible purchase of four CANDU reactors with Canadian officials in 1982, but these discussions were not continued.[14]

Thus, while Middle Eastern nations have considered nuclear power programs, few have carried these plans very far, and those that have, have experienced delays—Iran's program came to a stalemate during the revolution, and Egypt is still negotiating for the purchase of its first commercial reactor. It is unlikely that any Middle Eastern nation will have an operating commercial reactor before the mid-1990's.

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[8] See "Egypt: Nuclear Bids In—Will Financing Follow?," *Middle East Economic Digest*, Dec. 2, 1983. See also, Paul Taylor, "U.S. and Japanese Groups Link in Egyptian Nuclear Power Bid," *Financial Times*, Sept. 1, 1983, p. 1; "Consultant's Bid to Egypt Show Huge Gap; EDF Leads French Reactor Offer," *Nucleonics Week*, vol. 23, No. 4, Jan. 28, 1982, p. 1.

[9] Robin Miller, "Nuclear Power Plans Outlined," *Jamahiriyah Review*, No. 22, March 1982, p. 17. See also, James Everett Katz and Onkar S. Marwah, *Nuclear Power in Developing Countries* (Lexington, Mass.: D. C. Heath, 1982), p. 8. Press reports indicate that the Belgian firm Belgonucleaire may also participate in the project. See "Libya—Belgian Firm to Supply Plants," Paris International Press Service, 1245 GMT, May 23, 1984, reported in FBIS, May 23, 1984.

[10] Rob Laufer, "Syria Plans Nuclear Power Unit by 1991," *Nucleonics Week*, vol. 22, No. 24, June 18, 1981, p. 1.

[11] Adnan Shihab-Eldin and Yusef Rashid, "Cooperative Development of Nuclear Energy in the Arab World," paper presented at the Second Arab Energy Conference, Mar. 6-11, 1982, sponsored by the League of Arab States, the Arab Fund for Economic and Social Development, Arab Industrial Development Organization, and Organization of Arab Petroleum Exporting Countries, pp. 10 and 20.

[12] "Contract with USSR to Study Nuclear Power Site," JN071201 Baghdad INA in Arabic 1052 GMT 7 March 84, reported in FBIS, *Daily Report: Middle East and Africa*, Mar. 7, 1984, vol. v., No. 046, annex No. 016.

[13] See Adnan Mustafa, "Nuclear Fuel Resources in the Arab World," paper presented at Second Arab Energy Conference, ibid.; see also "Interministerial Committee Set Up to Define Nuclear Energy Policy," *El Moudjahid* (Algerie), Nov. 1, 1980, p. 5.

[14] Canadian officials reported that they would not sell the reactors unless Kuwait became a party to the NPT. See "Offer to Sell Reactors Denied," *Canadian Radio*, in FBIS Jan. 28, 1982. Kuwait has signed but not ratified the NPT.

RESEARCH REACTORS

A second type of nuclear facility currently in operation in the Middle East, the research reactor, is used in conjunction with nuclear research at several training centers in the Middle East. Research reactors provide a source of neutrons and/or gamma radiation for physics, biology, chemistry, and metallurgy research; for investigation of the effects of radiation on many types of materials; and for production of isotopes used in medicine, industry, agriculture, and training and teaching. There are more than 350 research reactors worldwide.

Israel was the first Middle Eastern country to build a research reactor; in 1960 it completed a 5-MWt[15] IRR-1 research reactor using highly enriched uranium (HEU) and a few years later, a 26-MWt research reactor at Dimona.[16]

Egypt is the Islamic nation with the oldest research reactor in the Middle East. Built with Soviet assistance in the early 1960's, Egypt's 2-MWt research reactor using 10 percent enriched uranium is located at the Inchass Nuclear Research Center. It has been operated since 1972 by Egyptians without foreign assistance. In addition, West Germany has agreed to sell Egypt a 1-MWt research reactor.[17]

Iraq has constructed the largest number of research reactors. One is a small pool-type research reactor supplied by the Soviets, which was upgraded to 5 MWt in 1978 and is located at the Tuwaitha Nuclear Research Center. This IRT-2000 reactor is suitable for small-scale medical and civilian research applications and can be fueled with uranium of various enrichments. Two other research reactors were supplied by the French in the 1970's. Isis (or Tamuz 2) is a small 800-kilowatt critical assembly, which has a negligible annual fuel utilization. Osirak, as the French called it, or Tamuz 1 was a research reactor before it was destroyed by Israel in 1981. According to the IAEA, this reactor had a capacity of 40 MWt. Iraq has discussed rebuilding the reactor with the French, but this has not occurred. Among the points of controversy was the suggestion that medium-enriched uranium (MEU) fuel be used in a rebuilt reactor, which was opposed by Iraq.[18]

It is not clear whether Iran's 5-MWt reactor provided by the United States in the 1960's and located at the Teheran University Nuclear Center is still in operation.[19] Finally, Libya has a 10-MWt Soviet-built (WWR-C) research reactor fueled by 80 percent enriched uranium.[20]

A number of nations have plans for or are considering building research reactors. Algeria, for example, has a nuclear research institute and has carried out some discussions with the U.S. firm General Atomics concerning construction of a research reactor, but no purchase has been announced.[21] Morocco has purchased a 100-kilowatt TRIGA Mark I research reactor from General Atomics, but the facility has not yet been constructed.[22] Saudi Arabia has plans to build a nuclear research center, but no research reactor has yet been built, although feasiblity studies have been carried out.[23] In Kuwait, similarly, discussions about research reactors have been pursued, but those organizations interested in purchasing one have not appropriated funding for fiscal year 1984 to proceed. Likewise, Syria and Tunisia have also considered research reactors, but in neither case have negotiations been finalized.

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[15] 1 MWt would produce approximately 0.3 Mwe. Unless otherwise noted, MW indicates megawatts (electric). Thermal megawatts (MWt) is used to refer to capacity of reactors not used for production of electricity.

[16] No U.S. observers have inspected the Dimona facility since 1969, and Israel says that it has no nuclear weapons. However, informed opinion is that Israel does have nuclear weapons capability. Some claim that the Dimona reactor was upgraded to 70 MWt capacity in the 1970's. See George H. Quester, "Nuclear Weapons and Israel," *The Middle East Journal*, vol. 37, No. 4, autumn 1983, p. 548.

[17] "German Minister Seeks Trade Increase," *Middle East Economic Digest*, vol. 26, No. 13, 1982.

[18] See "France, Iraq Unveil Secret Nuclear Accord," *Energy Daily*, June 19, 1981; "Mideast Nuclear," *Reuters Report*, Mar. 19, 1982. The U.S. Department of Energy cited a 70 MWt capacity, but the French said that the reactor had a 40 MWt capacity. Due to limitations of the heat rejection system, the reactor would have been operated at 40 MWt, according to the IAEA. See IAEA, Background Briefing Paper, "Safeguards and the Iraq Nuclear Centre," December 1981.

[19] Zivia A. Wurtele, Gergory S. Jones, Beverly C. Rowen, and Marcy Agmon, *Nuclear Proliferation Prospects for the Middle East and South Asia* (Marina del Rey: Pan Heuristics, 1981), p. A-18.

[20] "Development of Nuclear Capability Reviewed," *The Arab World Weekly* (Jan. 24, 1981), reprinted in JPRS *Nuclear Development and Proliferation Worldwide Report #84, Mar. 3, 1981.*

[21] "Algeria To Go Nuclear," *8 Days*, Feb. 28, 1981, pp. 46-47.

[22] "Extraction of Uranium from Arab Phosphate: The Arab World Decides to Turn to the Nuclear Alternative," *Al Duster* (London), No. 231, Apr. 26, 1982.

ENRICHMENT AND REPROCESSING FACILITIES

No Middle Eastern nation currently has such facilities on a commercial scale, nor is it likely that any of these nations will have commercial-scale enrichment and reprocessing facilities in this century. However, a number of countries are reported to have small-scale reprocessing facilities. (There is, however, no authoritative source identifying all small reprocessing facilities worldwide.)

Only a few Middle Eastern nations are reported to have small-scale reprocessing facilities in operation. At the Inshass Center, Egypt has a small complex of hot cells which were supplied by the French. Iraq contracted with the Italian firm SNIA in 1976 for a radiochemistry laboratory. Construction on the facility was completed in 1978. The lab consisted of a hot cell complex. Such hot cells are used to manipulate radioactive substances and have many potential peaceful uses, but also could be used to separate small quantities of plutonium from dissolved uranium in the Osirak reactor.

Italy also reportedly agreed to provide Iraq with four additional labs designed to give the Iraqis "mastery of the fuel cycle," in the words of Dr. Umberto Colombo, head of the firm CNEN. These labs are said to have included a fuel fabrication lab, a chemical engineering lab, and a radioisotope lab. The exact status of these projects is not clear.[24]

The only other laboratory-scale sensitive research reported in the Middle East are efforts in Israel and prerevolutionary Iran. Iran acquired experimental laser enrichment technology in late 1978 from a U.S. firm. The fate of this equipment is unknown. Observers believe that separation facilities in the form of hot cells exist at two Israeli reactor facilities.[25]

PATHS TO NUCLEAR WEAPONS

A number of Middle Eastern nations do possess research reactors and laboratory-scale sensitive facilities, and a few have plans for nuclear power programs. A key question is whether these facilities now in place, or those planned, could result in proliferation of nuclear weapons in the Middle East. The term "proliferation" is used here to refer not only to the manufacture or acquisition of nuclear weapons by nations that do not now possess them, but also to programs that prepare for the construction or testing of a weapon and that would allow nations to produce a nuclear device in a very short period of time.[26]

Israel, for example, is generally credited with the capability to produce nuclear weapons in a very short period of time. Just as commercial nuclear power development promises to enhance the electricity-generating capacity of Middle Eastern nations, nuclear weapons proliferation would have significant implications for the balance of power in the region, including not only tension between Israel and its Arab neighbors but also rivalries among Islamic states, and for the strategic interests of the superpowers.

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[23] Between 1976 and 1982 General Atomics attempted to persuade King Saud University to purchase a small Triga Mark 1 reactor, but was unsuccessful. The Saudis signed a memorandum of understanding with Great Britain in late 1981 to facilitate nuclear research and training. The physics department at the University of Petroleum and Minerals has ordered a 14-MeV neutron generator, and has plans for a linear accelerator. The University of Riyadh is acquiring a 2.5-MeV Van de Graaf generator for its physics department. Thus, the Saudis are initiating a low-level research program.

[24] For the most detailed published account, see Richard Wilson, "A Visit to the Bombed Nuclear Reactor at Tuwaitha, Iraq," *Nature*, vol. 302, Mar. 31, 1983, pp. 373-376. The report is based on observations made onsite in early 1983. More recent reports of onsite conditions are not available. According to information provided by Dr. Wilson in July 1984, about 30 scientists and 100 others (non-military), as well as 100 soldiers are onsite at Tuwaitha; French and Italian technicians are not present.

[25] Roger F. Pajak, *Nuclear Proliferation in the Middle East* (Washington, D.C.: National Defense University, 1982), p. 38.

[26] This definition, and a more detailed explanation of the weapons applications of various nuclear technologies, can be found in *Nuclear Proliferation and Safeguards* (Washington, D.C.: U.S. Congress, Office of Technology Assessment, OTA-E-48, 1977) and appendix vol. II.

Commercial power reactors cannot, by themselves, be used to manufacture nuclear weapons. To make nuclear weapons, plutonium or highly enriched uranium is needed. Low-enriched uranium is used as fuel for light-water nuclear power reactors. Such fuel would have to be "enriched" in an enrichment plant to boost the concentration of uranium 235 to the level required for weapons production. OTA's study, *Nuclear Proliferation and Safeguards,* stated that "it is *impossible,* not merely impractical, to use light-water reactor or CANDU reactor uranium fuel in a nuclear fission explosive without an expensive and technologically advanced enrichment facility."[27]

Another method of producing weapons involves plutonium. Plutonium is produced when uranium atoms in reactor fuel are bombarded by neutrons during the normal operation of a nuclear reactor. Such plutonium, however, must be separated from used ("spent") fuel through a process called reprocessing. Therefore, in addition to a light-water reactor, either an enrichment facility or a reprocessing facility would be required to produce suitable uranium or plutonium for weapons production.

All of the nations that now have nuclear weapons have obtained them through "dedicated" programs devoted to military purposes, but there is at least a conceptual possibility that a country might use commercial nuclear facilities, specifically reactors, in conjunction with an enrichment or recprocessing facility, to acquire or produce weapons materials—plutonium and/or highly enriched uranium. Diversion of materials needed for weapons production from a commercial reactor could occur through evasion of safeguards or through use of unsafeguarded facilities.

Because light-water reactors require considerable time for removing "spent" fuel assemblies and replacing them with new fuel assemblies, it is unlikely that spent fuel could be diverted to a reprocessing plant for weapons use without considerable economic and power penalties, except at a normal discharge and loading operation or from the spent fuel storage pool. This would make clandestine evasion of safeguards difficult.

Use of commercial reactors without associated enrichment or reprocessing facilities constitutes at best a very indirect path to nuclear weapons production from the standpoint of the manpower involved as well. There is a limited overlap between personnel requirements for a commercial nuclear program and a nuclear weapons program. About a quarter of the personnel normally involved in operating a commercial reactor require specialized nuclear training. A weapons program would also require personnel with specialized training, some of it in different areas. Therefore, some personnel working in a commercial program could be used for a weapons program (assuming that many were retrained) along with personnel possessing specialized skills in areas such as nuclear engineering, physics, and the handling of high (nonnuclear) explosives.[28]

In Egypt, the Middle Eastern nation most likely to acquire a new commercial power plant in the next decade, policymakers have indicated their preference for turnkey plants. With a turnkey contract, indigenous personnel are gradually trained either in the host country or abroad, and the contractor may also be responsible for operations. Thus, the turnkey approach implies a delay in development of indigenous capabilities. For a nation that wants to keep its nuclear weapons option open, commercial power plants (particularly turnkey plants) raise no direct proliferation considerations. Indirectly and over a long time, however, such facilities could contribute to the creation and maintenance of a technical infrastructure that would be useful if the nation later decided to develop nuclear weapons.

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[27] For analysis of diversion potential from light-water reactor and other nuclear power systems, see *Nuclear Proliferation and Safeguards,* op. cit., pp. 23, 154-189.

[28] The total number of personnel required to operate a nuclear plant in the United States is 600 to 800, including both onsite and offsite personnel. See Glenn A. Whan and Robert L. Long, "Nuclear Power: Manpower and Training Requirements," paper presented at the Workshop on Nuclear-Electric Power in the Asia-Pacific Region, Honolulu, Hawaii, Jan. 24, 1983.

In contrast to commercial power reactors, which do not pose proliferation risks by themselves, are small-scale sensitive facilities which can be used in conjunction with research or power reactors to extract small quantities of weapons materials if facilities are unsafeguarded or safeguards are evaded.

During the next decade, it is quite likely that more research reactors will be supplied to contribute to the creation of a local science and technology infrastructure in developing countries. However, research reactors can also be used, at least theoretically, as components of programs oriented toward weapons production. The critical considerations are: 1) the size of the reactor, with those over 10 MWt of particular concern; 2) the use of very highly enriched uranium as a fuel; 3) the presence of reprocessing technology; 4) the strength of safeguards to monitor fuel and spent fuel stockpiled within the country; and 5) the operation of such reactors.[29]

One concern is that HEU could be diverted and used in weapons production, although this would entail considerable effort to obtain sufficient quantities. Most safeguarded research reactors fueled by HEU contain less than 25 kg of U^{235} in inventory. During 1981, the International Atomic Energy Agency (IAEA) conducted inspections at 176 research reactors and critical assemblies, of which about 43 contained more than one significant quantity (SQ)[30] of highly enriched uranium or plutonium.

Another concern is that more powerful research reactors might be modified to produce plutonium through irradiation of uranium targets in the core or the use of a uranium blanket around the core.[31] Small, but significant, quantities of plutonium could be produced in reactors with a capacity of more than 10 MWt. (If such a reactor were fueled with HEU, the uranium inventory would probably be of more proliferation concern than would potential plutonium production.) IAEA inspections would detect activity involving modifications in safeguarded facilites, but some plutonium could at least theoretically be produced between inspections.

In the event that quantities of plutonium could be produced through such means, ability to produce nuclear weapons would depend on the presence of a reprocessing facility. Hot cells, such as those in the small radiochemistry lab provided by the Italians to Iraq, are generally limited to gram-scale reprocessing—therefore limiting the amount of plutonium that could be produced annually to several kilograms, at most.

Research reactors larger than 10 MWt and fueled by very highly enriched uranium (VHEU) thus raise proliferation concerns. These include reactors constructed in the 1960's to the late 1970's. More recently, the United States, France, and other nations initiated efforts to encourage the use of low enriched uranium (LEU) in order to reduce the potential for nuclear weapons proliferation from diversion of HEU fuel. There have been few U.S. research reactor exports in recent years; the United States exercises restraints over research reactors abroad through decisions about supply of enriched uranium fuel. Libya is the only Islamic nation with a research reactor having a capacity of 10 MWt.[32] The Israeli 26-thermal megawatt (MWt) Dimona reactor is estimated to be capable of producing 8 kilograms of plutonium (kg Pu) annually.[33]

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[29] The discussion on research reactors draws from the work of Marvin M. Miller and Carol Ann Eberhard, "The Potential for Upgrading Safeguards Procedures at Research Reactors Fueled with Highly Enriched Uranium," for the U.S. Arms Control and Disarmament Agency, contract No. AC2NC104, November 1982.

[30] One SQ = 25 kg of U^{235}. Most of the proliferation concern regarding civlian applications has been with the use of very highly enriched uranium (VHEU) containing 93 percent U^{235} used in research reactors. Smaller quantities of about 5 kg U^{235} or between 2 and 8 kg Pu are also of proliferation concern. See Miller and Eberhard, "The Potential for Upgrading Procedures," op. cit.

[31] See Hans Gruemm, "Safeguards and Tamuz: Setting the Record Straight," *IAEA Bulletin*, vol. 23, No. 4, December 1981.

[32] Richard Wilson confirmed in August 1984 that the Soviet WWR-C reactor at Tuwaitha, Iraq, has a 5-MWt capacity.

For nations wishing to produce weapons covertly, it is at least possible for research reactors to provide an avenue, albeit one much less convenient than acquisition of large-scale sensitive facilities. However, diverting enough HEU or plutonium from these small reactors to support a weapons program (especially one geared to the production of more than one experimental device) would take some time; during that time, a strong safeguards program would probably detect diversion, or at least suspicious circumstances.

The nuclear technologies raising greatest concern in terms of proliferation are enrichment and reprocessing technologies. Because Iraq has purchased laboratory-scale reprocessing equipment, concerns arose about whether or not that country was attempting to produce nuclear weapons, a subject which will be discussed in more detail in the section that follows. Sensitive facilities raise proliferation concerns because they could be used in a weapons program if safeguards were inadequate or circumvented. Requiring only a modest sum of money and a modest construction effort in comparison to large-scale facilities, smaller-scale reprocessing facilities could be used to produce clandestinely the material for a small number of bombs annually if the spent fuel were available. Although time-consuming, such an operation is not technically difficult.

Construction of either unsafeguarded enrichment or reprocessing facilities would constitute a violation of the Nuclear Nonproliferation Treaty (NPT), which all Middle Eastern nations except Algeria, Israel, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE) have ratified or signed. Dedicated weapons programs could potentially use some safeguarded facilities: e.g., in theory low-enriched uranium could be diverted from a safeguarded reactor and boosted in a dedicated enrichment plant. However, this would be a time-consuming and difficult process if safeguards were in place.

As OTA's study of *Nuclear Proliferation and Safeguards* outlined, the path to weapons production most accessible to developing countries with modest technical insfrastructure is one involving construction of a 25-MWt plutonium production reactor (which would produce enough plutonium for one or two explosives per year) and a small reprocessing plant. The two facilities together would require 10 to 20 professional engineers for operation. The reprocessing plant requires more expertise in remote control, the handling of very radioactive materials, and chemical engineering procedures, but the equipment and supplies needed are generally available on world markets.[34]

A more demanding route would be the use of centrifuge enrichment facilities. In either case, the facilities would have to be constructed and operated without detection. Five years is the estimated time between the point when a nation begins discussion of a dedicated route and the point when the weapons material could be in hand. In addition to these two dedicated routes, the next decade could see progress in advanced isotope separation technologies such as laser isotope separation, which could greatly accentuate proliferation problems.

It must be emphasized that in the Middle East, where manpower is a major constraint on transfer of advanced technologies, it would be difficult to assemble a team with the appropriate specialized skills. Even in newly industrializing countries, such as India, with much larger pools of scientific and engineering manpower, construction of reactors has required more skilled workers than are needed in industrial countries. A small national program designed to produce weapons clandestinely without testing would require a core group of more than a dozen well-trained and very competent people experienced in many fields of science and engineering, and access to open technical literature.

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[33] Miller and Eberhard, op. cit., p. 21.

[34] See *Nuclear Proliferation and Safeguards*, op. cit., pp. 174-79.

In addition, a staff of technicians, diverse laboratory facilities, a field-test facility for handling experiments with large-scale (nonnuclear) explosives, and financial and organizational resources to purchase or fabricate items required for the assembly mechanism would be needed.[35] Any one of these components might be easy to acquire, but Middle Eastern countries face strong obstacles to assembling the entire package of skills needed and to retraining personnel over a long period of time. More important than the sophistication of the facilities is the competence of the individuals involved in the program. Manpower is thus a critical constraint to nuclear technology transfer in the Islamic Middle East.

A final route to nuclear weapons is theft or purchase of nuclear material or weapons on the black market. This would eliminate the need for the expensive and demanding technologies described above. Libya has reportedly attempted to purchase not only sensitive nuclear technologies (reprocessing and enrichment) but also a nuclear bomb.[36] While there is no evidence that such a black market now exists, one may develop if second-tier suppliers enter the market to sell unsafeguarded facilities and if plutonium recycle becomes more extensive. The black market is the least technically demanding route to nuclear weapons.

This discussion indicates an ascending order of proliferation problems, with commercial reactors at the bottom and sensitive facilities at the top of the list. In the case of power reactors, the commercial applications are most important for these Middle Eastern nations, particularly where the recipient possesses none of the more sophisticated reprocessing or enrichment equipment. For commercial powerplants, particularly those built through turnkey contracts, there is no direct proliferation risk if reprocessing and enrichment facilities are not present.

The most worrisome path to a weapons capability would be one that involves acquisition of small-scale fuel cycle facilities that could be rationalized, more or less reasonably, as logical components of an orderly long-term effort to develop a broad capability for using nuclear power. Such facilities, designed with great flexibility of operation in mind, may be capable of producing materials adequate for one to a few weapons per year. However, it must be emphasized that such facilities would have to operate over considerable periods of time and escape safeguards in order to be used for weapons production.

If a nation were to succeed in this covert weapons production path, it might produce a few small-scale, untested nuclear weapons. Some observers believe that in the Islamic Middle East a number of nations—Iraq, Libya, Egypt, Syria, and Iran[37]—might by the turn of the century be in a position to develop such "small nuclear forces" (comprising 5 to 10 deliverable and militarily serviceable fission bombs or warheads).

If present nuclear supplier policies remain in force and are accepted by new suppliers, the Islamic nations of the Middle East will not be able by themselves to produce weapons for many years, unless they abrogate or violate safeguarding agreements. In that case, production of weapons would be difficult, and because the separation of plutonium required for a single weapon would take many months (depending on the type of reprocessing facility), detection of the program would be probable.

However, if new suppliers enter the market who are willing to provide sensitive facilities and assistance, and if recipients abrogate safeguards, the possibility of nuclear weapons proliferation would increase dramatically. Table 84 outlines the nuclear proliferation implications of policies of supplier and recipient countries, in their current form and under theoretical modifications.

The section that follows explores the plans of these and other Middle Eastern countries for nuclear power development. The technical capabilities of these nations to utilize nuclear technologies are evaluated in the light of stated policy toward commercial power development and toward weapons programs.

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[35] Ibid., p. 140.

[36] Steven J. Rosen, *Nuclear Proliferation and the Near-Nuclear Countries*, (Cambridge, Mass.: Ballinger, 1975), p. 178.

[37] Center for Strategic and International Studies, *Proliferation of Small Nuclear Forces* (Washington: CSIS, 1983), p. i.

Table 84.—Implications of Technology Transfer Policies for Proliferation of Nuclear Weapons

Recipient policies	Supplier policies	Implications for weapons programs
Acceptance of full-scope safeguards (party to NPT or equivalent)	No changes in policy; no new suppliers	1. Recipients could obtain reactors but no capability for obtaining plutonium or HEU, except through facilities of an undeclared or clandestine nature (although abrogation of safeguards would allow for Pu path). Weapons capability would be limited: several years for a single weapon
	Suppliers, possibly new ones, willing to provide sensitive facilities (as well as reactors), with, however, insistence on safeguards on facilities they provide	2. Could obtain everything necessary for a fairly large-scale weapons program, but weapons could be obtained only after abrogation or violation of safeguarding agreements
	Suppliers, possibly new ones, willing to provide anything without safeguards	3. Same as 2, above
Acceptance of safeguards only as required by individual suppliers	No change in policy; no new suppliers	4. Same as 1
	Suppliers willing to provide sensitive facilities (as well as reactors), with insistence on safeguards at least on facilities they provide	5. Same as 2
	Suppliers willing to provide anything without safeguards	6. Recipients could acquire essentially unlimited weapons potential
Unwilling to accept safeguards on anything	No changes in policy; no new suppliers	7. Weapons capability for recipients confined to currently existing facilities. Recipient might not be able to obtain additional shipments of HEU; therefore, proliferation potential remote
	Suppliers willing to provide sensitive facilities (as well as reactors), with insistence on safeguards on at least facilities they provide	8. Same as 7, above
	Suppliers willing to provide anything	9. Same as 6 above

SOURCE: Office of Technology Assessment

PERSPECTIVES OF RECIPIENT COUNTRIES ON NUCLEAR TECHNOLOGY TRANSFERS

A number of economic, political, and manpower-related considerations restrict the ability of Middle Eastern nations to develop nuclear power and pursue a nuclear weapons option. Despite the growing awareness of the problems associated with nuclear power—including waste management, potential for accidents, and economic costs—some developing nations see nuclear power as essential for their economic development. Likewise, despite the potentially destabilizing effects of nuclear weapons acquisition, some developing nations have apparently invested considerable resources in attempting to keep a nuclear weapons option open.

This section explores the various types of constraints on nuclear technology acquisition in the Middle East, with reference to specific countries and programs. One important theme is that the manpower required for indigenous technology development is a significant constraint for all of these nations. Also, the volatility and early stage of nuclear programs in the Middle East reflect an absence in most of these countries of the political agreement and leadership needed to support a large-scale nuclear program.

ECONOMIC AND ENERGY CONSIDERATIONS

In deciding whether to promote commercial nuclear power, developing nations face significant constraints related to the following requirements: financing, validity of projected energy demand, electricity grid size, political agreement concerning the appropriateness of nuclear power in view of overall development strategies, and competing requirements for resources. OTA's analysis leads to the conclusion that, despite the potential which nuclear power holds for meeting anticipated rapid growth in electricity demand, only a few developing Middle Eastern nations are likely to have operating power reactors within this century. Egypt, the Middle Eastern nation with the most extensive program for nuclear power development, is likely to obtain nuclear reactors only with subsidized financing.

Financial Requirements

In developing countries, where financial resources are scarce and demand for central power station electricity comparatively small, coal, oil, and hydropower have commonly been used to meet electrical demand. For Middle Eastern nations, particularly those with abundant hydrocarbon resources, the rationale for commercial nuclear power is far from clear. Herein lies the central question: What changes in the incentives and disincentives for nuclear power which heretofore weighed against nuclear power in the Middle East might "tip the logic" in its favor?

Cost and financing terms for the purchase of nuclear reactors severely constrain the ability of many developing nations to acquire reactors. While costs of reactors vary, depending on a variety of factors such as reactor types, safety standards, and construction delays, a 1,000-MWe reactor costs a minimum of about $1 billion in industrial countries, and could run double or triple that amount elsewhere. Including indirect costs (interest, manpower training, administration), a 600-MWe reactor alone has been estimated at $1.5-$2 billion (in 1981 dollars) for developing nations.[38]

Financial constraints have been particularly salient for Egypt. Despite Egypt's signed letter of intent to buy a 626-MWe pressurized-water reactor from Westinghouse in 1976, financing of $1.2 billion in loans was never resolved and the sale was never completed.[39] In 1981, Egypt set up a alternative energy fund whereby oil revenues were to have been set aside at the rate of $500 million annually. As of December 1983, Egyptian Government officials stated that $800 million had been deposited in this fund,[40] and that another $300 million would be added in 1984. Financing continues to be a major factor influencing Egypt's nuclear power plans.

The reluctance of the U.S. Export-Import Bank to grant loans and congressional opposition to loans to finance U.S. nuclear reactor exports has been a continuing issue in negotiations carried out by U.S. firms.[41] Similarly, financing has been the sticking point in Egyptian negotiations with the French for two 950-MWe pressurized-water reactors valued at $2 billion. Egypt announced plans to finance 20 percent of the project itself and sought financing for 80 percent of the project at 8 percent interest rates. For the last 2 years, the projected date for beginning construction of the two reactors has been continually postponed.

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[38] In Taiwan, where labor costs are very low and skilled manpower exists, two 950-MWe reactors were built at a total cost of $1.7 billion in 1983. This low cost reflects the lack of public hearings and very limited backfitting, conditions not present in the United States. See "Nuclear Costs," *Engineering News-Record*, May 26, 1983, pp. 27-28. See Ian Smart, "The Consideration of Nuclear Power," in James Everett Katz and Onkar Marwah (Marwah) *Nuclear Power in Developing Countries: An Analysis of Decision Making* (Lexington, Mass.: Lexington Books, 1982), p. 28.

[39] See U.S. Department of Energy, *Joint Egypt-United States Report on Egypt- United States Cooperative Energy Assessment*, 5 vols. (Washington, D.C.: U.S. Government Printing Office, 1979).

[40] See "Seminar Discusses Nuclear Safety," London Al-Sharq Al-Awsat in Arabic, Nov. 24, 1983, p. 7 reported in JPRS TWD 84-002; see also Charles Richards, "Four Bids Expected for Egypt N-Plant," *Financial Times*, Nov. 24, 1983.

[41] "Egypt Seeking Direct U.S. Aid for Nuclear Plant Purchase," *Nucleonics Week*, vol. 21, Feb. 14, 1980, p. 2.

For a country like Egypt, which has limited oil resources, a rising demand for food imports, and growing government expenditures, the viability of its nuclear program has been strongly affected by financing problems. With declining oil prices, remittances from Egyptian workers abroad initially fell, as did income from the Suez Canal. Egypt's current account deficit increased from $820 million in fiscal year 1979-80 to $1,406 million in fiscal year 1982-83.[42]

The nation's changed financial position is illustrated by its modified requests for external financing of nuclear reactor construction: In 1980, Egypt was negotiating to finance 50 percent of the reactor project at 8 percent interest; in 1982, 80 percent financing was requested at the same interest rate. Meanwhile, contributions to the alternative energy fund fell from the $500 million per annum announced in 1981 to $150 million in 1982.[43] All of these factors suggest that unless Egypt is offered a nuclear reactor at highly subsidized rates, its current nuclear plans are unlikely to come to fruition.

The history of Iran's nuclear program illustrates that even in oil-rich developing nations, political difficulties may arise from excessive costs accompanying a rapidly developing nuclear program. In 1975, the Canadian consulting firm Monenco (Montreal Engineering Co. Ltd.) estimated nuclear construction costs in Iran at $690 per kilowatt installed capacity. At the time, this estimate made nuclear power appear very attractive; cost estimates compared favorably with an average $700 to $1,000 per kilowatt for developed countries. However, the installed costs approached $3,000 per kilowatt, as construction neared completion before termination of construction following the revolution.[44]

The cost discrepancies were due largely to inflation, cost overruns, large infrastructure expenditures for associated road and port construction, the system of commissions paid to royal family members, and the government's mismanagement of the bidding process. Critics charged that Iran's hasty drive to develop nuclear power met with such difficulties because, among other factors, decisionmakers lacked sufficient technical expertise.

Determinants of Electricity Demand

In addition to costs and financing terms, expectations about future demand for electricity are key considerations for planners in developing nations. The demand for energy, and specifically for electricity, is determined by a variety of factors, including population growth, economic growth, energy intensity of economic growth, energy prices, and technological change.

Population growth is a major factor affecting energy demand in developing countries. Based on current trends, population growth in all the Middle Eastern countries will remain high, at least until the end of the century. While population growth may eventually decline under the impact of urbanization, increases in education, income levels and standards of living will tend to lower mortality rates. Population growth in all of these nations is expected to average well above 2 percent annually until the turn of the century. The Persian Gulf States, as a group, are projected to experience the world's highest levels of population growth, averaging 2.6 percent annually, according to World Bank estimates.[45]

Expansion of Middle Eastern economies depends strongly on the rate of oil income. As chapter 14 explains, it is extremely difficult to predict economic growth rates for various Middle Eastern nations. However, if the current trend in slack oil prices continues, economic growth rates could fall far below those achieved by Middle Eastern nations during the 1973-74 and 1979-80 periods of dramatic expansion. Since many countries already have a large amount of electrical generating capacity in place or under construction, if economic growth proceeds at rates well below those of the 1970's, demand for additional generating capacity will be dampened. Therefore, as countries complete their conventional powerplants now under construction, there could even be overcapacity by the mid-1980's if Middle Eastern economies grow at a slower rate than anticipated in the early 1980's.

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[42] In 1982, Egypt's financial situation improved somewhat as earnings from the Suez Canal and remittances increased. See *Middle East Economic Digest*, Egypt Special Report, July 1983, p. 9. See also "Egypt's Economy on the Right Track?" *Middle East Economic Digest*, Dec. 2, 1983, p. 11.

[43] "In Brief," *Middle East Economic Digest*, vol. 26, No. 45, 1982. By early 1984, it was estimated that a total of $700 million to $900 million had been set aside under the fund.

[44] "Nuclear Still Wrong for Iran, But Events May Dictate Otherwise, Analyst Says," *Nucleonics Week*, Oct. 16, 1980, p. 6.

[45] World Bank, *World Development Report 1983*, p. 185. Population growth for Saudi Arabia for the period 1960-2000 is projected at 3.4 percent annually, 2.6 percent for Kuwait, and 2.0 percent for the UAE.

The structure of economic growth also has an important bearing on energy demand. Development strategies favoring industrialization and urbanization are more energy-intensive than strategies stressing agriculture and service sector development. Generally speaking, during the early stages of industrialization, increasing rates of growth in energy consumption occur. Those Middle Eastern nations where diversified heavy industrialization is under way will thus experience a more rapidly rising demand for electricity.

Demand for energy is also affected by prices. Governments in the Middle East tend to set oil-based fuel prices lower than the opportunity cost to the economy. In Egypt, for example, the price of kerosene used in home heating and cooking was 15 percent of the world market price in 1980.[46] Subsidized energy prices, which are politically popular but reduce incentives to conserve oil and to diversify to other energy sources, have probably contributed to acceleration of growth rates of energy consumption. During the period 1974-76, these rates averaged over 20 percent in Saudi Arabia, Libya, Algeria, and Egypt. Although some fuel efficiency improvements will take place through import of energy-efficient goods from nations where energy costs are high, significant energy savings are unlikely to occur in the presence of continued subsidization of energy prices.

All of these factors help influence the pattern of growth in demand for energy. Historically, the pattern has been that electricity consumption has risen more rapidly than energy consumption. Fifty years ago, for example, electricity represented only 4 percent of total primary energy consumption worldwide; today the figure is 27 percent. The proportion of commercial primary energy transformed into electricity is projected to rise in developing countries from 25 percent in 1980 to 31 percent in 1990.[47]

Annual growth rates of electricity consumption in the Middle Eastern countries during the past decade have been dramatic, in many countries approaching 15 percent. At this rate, consumption doubles in less than 5 years. In the late 1970's, Iran, Egypt, Algeria, and Saudi Arabia all ranked among the 20 largest consumers of commercial energy among developing countries.[48] Table 85 presents a summary of data relating to electricity demand in the region in the year 1980. Growth in electricity demand was, during the last decade, strikingly high in Gulf States such as Saudi Arabia and the UAE. During 1980, Egypt, Iran, and Saudi Arabia were the countries with the highest levels of electricity generation.

Interconnected Electricity Grids

There is a wide diversity in projections of electricity consumption for the next decade. Planners must consider regional and sectoral demand in their analysis of the relative costs of various electricity-generating systems. National projections of electricity demand and installed, connected, electrical grid, however, provide a general context for evaluating the rationale for nuclear power in specific countries.

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[46] World Bank figures, cited by R. Mabro, "Factors Affecting Future Energy Demand in Arab Countries," Second Arab Energy Conference, March 1982, Qatar.

[47] World Bank, *Energy in Developing Countries* (Washington, D.C.: World Bank, 1980), p. 63.

[48] Joy Dunkerley, William Ramsay, Lincoln Gordon, and Elizabeth Cecelski, *Energy Strategies for Developing Nations* (Washington, D.C.: Resources for the Future, 1981), p. 41.

Table 85.—Electrical Demand in the Middle East and North Africa

Country	Growth in demand for electricity 1971-80 (percent)	1980 installed capacity (GWe)	1980 installed connected grid	1980 electricity generated (GWh)[a]
Algeria	11.2	1.8	1.4	6,400
Egypt	8.7	4.5	4.5	18,500
Iran	7.5	5.3	5.3	17,000
Iraq	13.4	1.2	1.2	8,000
Jordan	16.6	0.4	0.4	1,100
Kuwait	13.4	2.8	2.6	9,300
Lebanon	2.7	0.7	0.7	1,800
Libya	17.0	1.2	0.9	3,100
Morocco	8.0	1.2	1.0	4,800
Oman	22.0	0.4	0.4	800
Qatar	16.5	0.5	0.5	1,500
Saudi Arabia[b]	40.0	6.2	3.0	17,000
Syria	12.5	1.1	0.9	3,400
Tunisia	10.7	0.9	0.8	2,800
UAE	36.0	1.1	1.1	4,500
AR Yemen[c]	18.0	0.02	0.02	70
PDR Yemen	0.0	0.07	0.07	200

[a] GWh = gigawatt-hours
[b] 1975-80
[c] 1971-77

NOTE: There is a wide disparity in data provided by the United Nations, the Central Intelligence Agency, and other sources concerning current electricity production as well as future growth projections. This compilation is based on U.N. data (which are gathered from government sources), but uses other estimates as well.

SOURCES: United Nations, *Statistical Yearbooks*, 1970-79; Central Intelligence Agency, *National Basic Intelligence Factbook*, 1974-82; additional materials used for each country estimate.

Photo credit: Aramco World Magazine

Power workmen string line on the Saudi Consolidated Electric Company's 230 kw power distribution network

A rule of thumb is that no single generating plant should constitute more than 10 percent of the system's total installed interconnected grid. This criterion is based on considerations of system reliability, reserve capacity, and economics. For example, if a power station in an electrical grid fails, reserve capacity must be brought online or portions of the load must be shed if the operating frequency of the system is not to be reduced by the added load of the remaining generators. To prevent this, some fraction of the installed electrical capacity is usually kept spinning in synchronization with the grid ("spinning reserve"), ready to take over in seconds until other components of the reserve capacity such as quick-start turbines can be brought online. Requirements for spinning reserve are smaller if load can be shed. Although load shedding is not a normal practice in industrialized countries, many developing countries shed load during peak hours. The smaller the size of the largest plant, the less reserve margin is needed to achieve a given system reliability.

Developing nations such as India, South Korea, Argentina, and Brazil all have had nuclear powerplants constituting less than 10 percent (and as low as 6 percent) of their grids at various times. On the other hand, in 1978 when Taiwan's Chin-shan 600-MWe reactor went critical, it represented 10 percent of a basically integrated national grid estimated at 6.5 GWe, and Pakistan's 125-MWe KANUPP reactor was designed with a capacity to make up 17 percent of Karachi's interconnected grid, although it has apparently rarely been operated at that level.

The 10 percent rule of thumb has been more common for industrialized countries than for developing countries, but it does help to indentify situations where addition of a nuclear reactor might not be clearly warrented. In practice, the upper limit may be higher or lower, depending on analysis of the nature of the grid, its load, and acceptable outages and load shedding. The rule of thumb points out cases where the installation of a power reactor might be questionable in terms of energy and economic considerations.

Applying the 10 percent rule to projections for electricity grids in various Middle Eastern nations indicates that most of them would not be in a position to install a 900-MWe reactor in this decade. Morocco, Tunisia, Jordan, Lebanon, Oman, Qatar, and North and South Yemen would not be in a position to do so until after the year 2000. Algeria, Iraq, Libya, Syria, and the UAE (only under high-growth assumptions) would have the installed grid to accept a 900-MWe reactor by the year 2000, but not as early as 1990. As table 86 indicates, only Egypt, Iran, Kuwait, and Saudi Arabia would be able to accommodate a 900-MWe reactor at 10 percent of grid size by the year 1990. These projections are based on assumptions that interconnected grids will be expanded rapidly. If Middle Eastern countries move to link their electricity grids, an option which has been discussed, power reactors might be accomodated earlier without violating the 10 percent rule.[49]

Small Reactors

The feasibility of nuclear power reactors could change substantially if small nuclear reactors (less than 600 MWe) were as readily available as large reactors on world markets. While a few older, small reactors are in operation, the Soviet 440-MWe reactor is the only small reactor currently available on the international market. According to U.S. industry, a major reason why such small reactors are not available is that there are marked differences in economies of scale for smaller units.

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[49] The Gulf Cooperation Council (GCC) nations are considering the feasibility of linking national grids in a regional power grid, but there is some doubt that these countries will be willing to contribute the massive capital costs that would be necessary. See "The Pros and Cons of Regional Power Grid," *Middle East Economic Digest*, vol. 27, No. 43, Oct. 28, 1983, p. 19. Interconnection of grids was discussed at the 2nd Arab Energy Conference, Mar. 6-11, 1982, held in Doha, Qatar.

Table 86.—Potential for Nuclear Reactor Installation, 1990, 2000

	1980 Actual grid capacity in GWe	Size of hypothetical reactor	Demand assumptions 1990 Low	Demand assumptions 1990 Hign	Demand assumptions 2000 Low	Demand assumptions 2000 High
Algeria	(1.4)	440 MWe				X
		900 MWe			X	X
Egypt	(4.5)	440	X	X	X	X
		900		X	X	X
Iran	(5.3)	440	X	X	X	X
		900	X	X	X	X
Iraq	(1.2)	440			X	X
		900				X
Kuwait	(2.6)	440	X	X	X	X
		900		X	X	X
Saudi Arabia . .	(3.0)	440	X	X	X	X
		900	X	X	X	X

X = reactor could be installed and not exceed 10 percent of projected grid

NOTES: Other countries *able* to install a 900-MWe reactor by 2000 under 10 percent assumptions: Libya, Syria, UAE under high electricity growth assumptions.
Other countries *unable* to install a 900-MWe reactor until *after* 2000 under the same assumptions: Morocco, Tunisia, Jordan, Lebanon, Oman, Qatar, North and South Yemen.

SOURCES: Computed from table 91, World Bank, *Energy in the Developing Countries* (World Bank Paper, August 1980), background information prepared for the paper and energy analyses; Joseph Egan, *Small Power Reactors in Less Developing Countries: Historical Analysis and Preliminary Market Survey* (Westmont, Ill.: ETA Engineering, Inc., 1981); additional sources for individual countries. (For example, the high demand estimate for Egypt is based on U.S. Department of Energy, and the low demand estimate is based on Shuli, as indicated in table 93.

For reactors larger than 600-MWe, a 0.7 scaling law is normally applied to **direct** construction costs. Therefore, a 1,200-MWe reactor would cost only about 60 percent more to build than would a 600-MWe reactor. The standard unit built by major reactor vendors increased to the 900-1,200-MWe range typical today; these larger reactors are more appropriate for industrialized nations where grid size is not a major constraint. A second factor is research and development (R&D) costs of several hundred million dollars, which firms must take into account when considering commercial development of small reactors. Industry experts believe that only if a firm could anticipate 5 to 10 orders for such reactors would it be reasonable to proceed with the necessary R&D.

Despite these factors, which some believe weigh against small reactors, some factors are in their favor. Smaller units may require less construction time, and therefore reduce prospects of cost overruns. It is not clear whether small reactors are more reliable than large reactors.[50] While some older, smaller reactors, such as the 220-MWe Rapp 1 heavy-water reactor in India, have poor reliability records, others such as the 325-MWe Atucha 1 heavy-water reactor, built by the German firm Kraftwerk Union in Argentina, have been worldwide leaders in uninterrupted operation. The Argentine reactor has had a capacity factor of 90 percent since it began operation in 1974. Small reactors have several potential features, such as compatibility with shop fabrication and barge transportation, that might tend to compensate for higher direct construction costs per kilowatt installed. To summarize, scale issues are complex. In the face of uncertain demand and limited resources, developing countries may see small reactors as attractive because of the possible reduced risk involved in building several short lead-time plants rather than one large unit.

Availability of small reactors would enhance the feasibility of nuclear power for developing nations with comparatively small grids. For example, if demand for electricity grows at a high rate, Iraq could be in a position by 1990 to install a 440-MWe reactor that would meet the 10 percent rule of thumb. Similarly, Egypt would be able to meet this criterion even under low electricity demand growth assumptions by 1990. Flexibilty would be increased further if large reactors could be derated (operated at lower capacities) during initial stages of operation and still be operated efficiently.

Two factors could significantly change the prospects for small-reactor sales. The Soviet Union has exported a few 440-MWe power reactors. If the Soviet-designed VVER 440-MWe reactor can be manufactured and sold at attractive prices, Middle Eastern nations may be interested in importing it. In 1980, there were five such reactors operating in the Soviet Union, and plans exist for installing a few additional reactors. However, since Soviet construction facilities are pressed to meet construction deadlines for larger reactors now at the center of Soviet nuclear plans, construction of the smaller reactors has been shifted to the Skoda Works in Czechoslovakia.

VVER 440 reactors, reported to be reasonably reliable and economical, will be installed in East European nations. The question is whether the Czech works will have the capacity for exports, and whether small reactors produced there will gain a reputation for reliability.[51] In addition, India has built a 235-MWe heavy-water reactor for domestic use, but it is not attractive for export.

The second possibility is that some of the Western firms with design concepts for small power reactors would decide on a commercialization strategy. A handful of companies in Western nations have such design concepts, and if such small reactor designs embodying inherent rather than engineered safety were commercialized, developing countries more concerned with safety in the post-Three Mile Island era might find them attractive. Kraftwerk Union of Germany, for example, has a design for a 400-MWe boiling water reactor that features uncomplicated safety technology. In all cases, however, these designs have not advanced beyond the drawing board, and a major R&D effort would be required in the country of origin to produce an attractive export product.[52] Nevertheless, if small reactors could be marketed near the turn of the century, that could change the prospects for nuclear power in some Middle Eastern countries.

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[50] C. Komonoff, *Power Plant Cost Escalation* (New York: Komonoff Energy Associates, 1981). See also, *Nuclear Power in an Age of Uncertainty* (Washington, D.C.: U.S. Congress, Office of Technology Assessment, OTA-E-216, 1984), pp. 106-107.

[51] See *Technology and Soviet Energy Availability* (Washington, D.C.: U.S. Congress, Office of Technology Assessment, OTA-ISC-153, 1979), pp. 116, 130, 295.

Other Incentives for Commercial Nuclear Power

Nuclear power plants have two other civilian applications—to supply process heat for desalination of sea water and in stimulating heavy oil production—which Middle Eastern nations may wish to develop in addition to generating electricity. Nuclear desalination is currently economically feasible only in conjunction with nuclear generation of electricity. While the UAE, Qatar, and Oman conventionally desalt large amounts of water, their electricity grids are too small and poorly integrated for introduction of nuclear desalination plants at the present time. In contrast, nuclear desalination appears more feasible for Saudi Arabia and Kuwait. The only commercially available option for nuclear desalination involves the use of light-water reactors, using backpressure steam or extracted steam. Other specially designed reactors, such as the French Thermos, the Swedish Secure, or Soviet designs, are not currently commercially available.

Economic tests of the feasibility of nuclear desalination depend on capital and fuel costs of the nuclear plants versus conventional plants, as well as on water demand and electricity requirements. As a general rule, if nuclear electricity is economically feasible, then the cogeneration of low-temperature steam[53] (used in desalination) makes the system more attractive. Small reactors have not been viewed as particularly attractive for desalination. Kuwait, for example, drafted specifications in 1977 for a 40 MWt water desalination and research reactor, but owing to the small scale of the reactor and to its multipurpose usage, the project was canceled when it was determined that the costs per kilowatt would have been extremely high.[54]

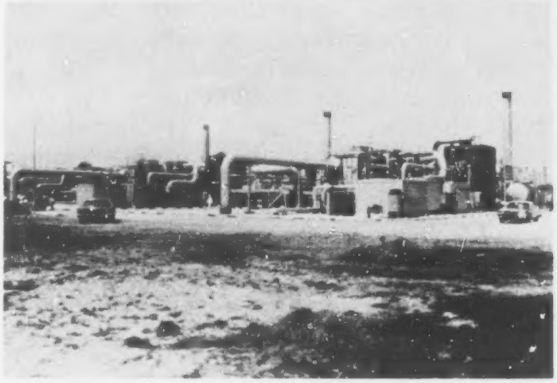

Photo credit: Saudi Arabian Ministry of Information

Al-Khobar Desalination Plant

Use of heat produced in nuclear powerplants for stimulating heavy oil[55] production does not appear to be a major option for Middle Eastern nations. Heavy oils sufficiently viscous to profit from enhanced steam recovery have been discovered in Kuwait and Libya, but they are of only marginal interest for these nations, given the large quantity of proved reserves of conventional oil. Nor would standard reactor designs produce steam of appropriate pressure and temperature to drive the large Middle Eastern oil reservoirs.

Uranium Resources

Presence of uranium deposits does not provide sufficient economic justification for a nuclear program. The mining and refining are expensive and enrichment is a complex and technically demanding operation; thus, most developing nations with commercial nuclear programs contract for supplies of enriched uranium.

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[52] See Joseph R. Egan, *Small Power Reactors in Less Developed Countries: Historical Analysis and Preliminary Market Survey* (Westmont, Ill.: ETA Engineering, Inc., 1981).

[53] Excess steam used in the production of electricity that can be used for other purposes.

[54] Power produced in this reactor would have cost $15,000 per kW. See Egan, op. cit., p. 5-1.

[55] Heavy oil is a term used to apply generally to any crude oil of less than 20 percent API (or with a specific gravity of 0.934 or more).

Algeria and Morocco illustrate this point. Algeria has the richest reserves of uranium of any Middle Eastern nation. These reserves have been estimated at 26,000 tonnes at a recovery price of $80/kg.[56] Algeria has been exploring for uranium since 1969; the state mining company, Sonorem, is building a uranium mine in Algeria that is expected to open in 1985 and produce 1,000 tonnes annually. Algeria could also produce uranium as a byproduct of phosphate mining, although no plans have been announced to do so. But while Algeria has emphasized its uranium reserves as an asset in nuclear planning, the nation has no commercial or research reactor.

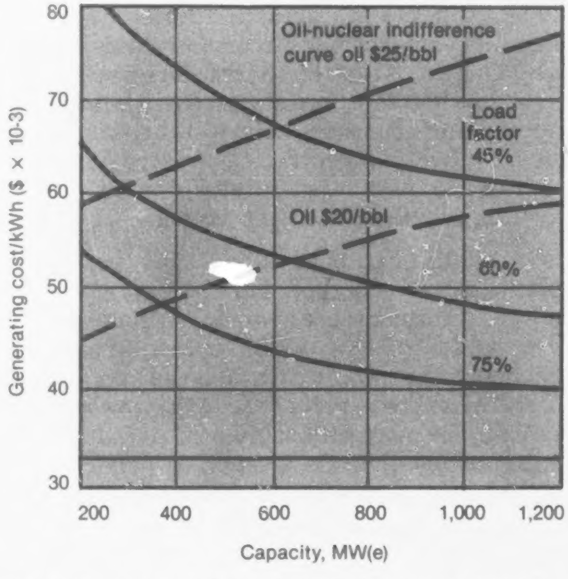
Morocco also has considerable uranium deposits, and uranium will be extracted in conjunction with fertilizer production. One plant is being modified for uranium production. When it begins operation in 1985, Morocco will be in a position to export 200 tonnes of uranium annually. Like Algeria, Morocco is also considering nuclear development, but the presence of uranium deposits has apparently not been a major factor in this regard.

Total world production of uranium is well in advance of demand, and this situation is expected to continue into the future.[57] Therefore, the attraction of uranium production is not great for developing nations not already exporting. Indeed, since all light-water reactors require enriched uranium for fuel, the purchase of enrichment services from abroad would still be a requirement, even for nations producing uranium.[58] However, uranium production by nations such as Algeria and Niger, which are not parties to the NPT, raises proliferation concerns, since they are not covered by safeguards and could theoretically export to nations having clandestine weapons programs.

Alternative Energy Sources

Judgments about nuclear power focus more on the alternative means of meeting electricity requirements than on the presence of uranium or the other commercial applications of nuclear power mentioned above. (The use of nuclear technologies in civilian research programs important for building a science and technology infrastructure will be discussed later in the context of technical manpower considerations.) In the Middle East the obvious alternatives to nuclear power are oil and gas. Cost comparisons between oil and nuclear energy are sensitive to the assumed price of oil, capital costs of oil and nuclear plants, costs of financing, and load factors. Figure 15 illustrates the cost of nuclear power as a function of plant size and load factor.

Figure 15.—Kilowatthour Cost as a Function of Plant Capacity and Load Factor



Note: This figure is based on the following assumptions: 30 year design (depreciation) life for both oil and nuclear plants, starting from the date of plant startup, with a cost of financing of 5 percent per year (in constant dollars); installed capital cost for oil plants of $1,000/kW(e) and for nuclear, $2 × 104 S-⅓/kW(e), where S is plant capacity in megawatts(e); fuel cost for nuclear of $0./01 kWh; opations and maintainence costs of $75/kW(capacity)-yr and $40 for nuclear and oil respectively. This figure should be regarded as illustrative only, considering the very great uncertainties that must attach to some of these parameters, particularly installed capital costs.

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[56] OECD Nuclear Energy Agency and IAEA, *Uranium: Resources, Production, and Demand* (Paris: OECD, 1982).

[57] See Department of Energy, *World Uranium Supply and Demand: Impact on Federal Policies* (Washington, D.C.: U.S. Government Printing Office, 1983), p. 36.

[58] The CANDU reactor operates on natural uranium, eliminating the need for enrichment.

The oil-nuclear indifference curve (in dashes) illustrates the relationship between load factor and break-even size for oil versus nuclear plants at two different assumed oil prices. Under the assumptions used, there will be an advantage for nuclear power for conditions to the right and below the oil-nuclear indifference curves. While this figure is merely illustrative, it suggests that if oil is priced at $25 per barrel, oil and nuclear-generated power will be about equally costly if nuclear powerplants of 630-MWe are used at a load factor of 45 percent. As the price of oil declines, the advantages of nuclear power are reduced, but such power is still attractive under reasonable load factors. However, if the oil price drops significantly, as it did in 1983, it will be more difficult to raise the capital to build nuclear plants, and the incentives for developing nuclear power will be further reduced.

Comparing gas and nuclear power is a more complex issue because up until 1979 most gas in the Middle East was flared. This occurred because the costs of collecting and transporting gas in the Middle East were extremely high in comparison to its market value in the Middle East. After the oil price increases, however, gas became more attractive in industrial operations such as petrochemical and fertilizer plants. Gas-fired generating capacity is being built while nuclear is not, and in many situations it will have an edge over nuclear power.

In addition to cost advantages, gas-fired plants can be installed more quickly, require lower investment, are available in small sizes, demand fewer highly skilled operating personnel, and raise fewer waste disposal and safety concerns. Some experts believe that associated gas may be more profitably used in industrial applications than in electricity generation, since the amount of gas available depends on the level of oil production.[59] The attraction of gas for electricity production is strongest in countries such as Saudi Arabia that have flared gas. There are, however, other potential uses for gas: in petrochemical production, and (for Algeria) exports.

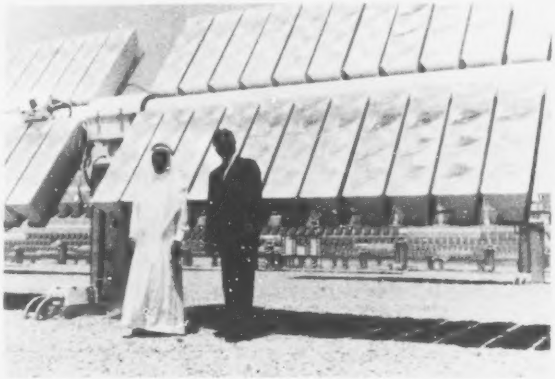

Photo credit: Saudi Arabian-United States Joint Commission on Economic Cooperation

Solar collector panels of the SOLERAS project, focusing on solar energy research and development

In addition, there is an extensive list of renewable energy resources—including solar energy—for Middle Eastern policymakers to consider. For many developing nations, including those in the Middle East, there is insufficient understanding of the potential role that these sources of energy might play. In the Middle East, some countries such as Iran and Iraq may be able to develop hydroelectric power more extensively.[60] Likewise, some believe Iran, Algeria, and Egypt could use biomass as an energy source.[61] Direct use of solar energy in areas such as the Sahel offers potential for crop drying and other agricultural uses.

Other technologies, such as solar photovaltaic systems, are under development, but are comparatively costly. The United States and Saudi Arabia jointly fund a $100 million solar energy research program through the U.S.-Saudi Joint Commission; the program includes establishment of a 350-kW power station in a "solar village." In Egypt, AID has sponsored research on solar energy for rural development. However, solar energy for rural electrification is a longer term option.

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[59] See T. Stauffer, "Oil Exporting Countries Need Nuclear Power," paper delivered at the Uranium Institute, London, September 1982.

[60] Dunkerley, et al., op. cit., pp. 160-161.

[61] Ibid., p. 178.

Nevertheless, technical assistance programs that help clarify all energy options make an important contribution.

The Economic Rationale for Nuclear Power in Egypt

Of all the nations in the Middle East, Egypt currently has the most extensive official plans for commercial nuclear power development. Its electricity grid is one of the largest in the Middle East, and electricity demand grew rapidly during the 1970's. By 1980, the installed grid capacity reached 4.5 GWe. The Egyptian Government has estimated that demand for electricity will grow at an annual rate of 9.9 percent from 1975 to 2000—to 12 GWe by 1990 and 26 GWe 2000.[62] Egypt's leaders believe that there is a strong economic rationale for nuclear power, based on these projections.

Egyptian officials have plans to develop a system for monitoring electricity flows throughout the connected grid at the National Energy Center. When the center is complete, it will have the capacity to accommodate planned nuclear plants, as well as thermal and hydroelectric facilities.

Alternative energy sources may be insufficient to meet projected rise in demand. Much of Egypt's hydroelectric energy potential is already exploited by the Aswan High Dam (2,100 MWe) and the Aswan Low Dam (345 MWe). The only options for expansion of hydroelectricity include installing additional turbines at the Aswan Dam and constructing three low dams and four barrages (for a total of about 500 MWe).[63] In addition, pumped storage with a potential of 4,300 MWe capacity could be added at seven locations along the Nile.[64] Finally, the Qattara Depression Project, which would involve excavating a canal and generating electricity from the flow of water from the Mediterranean into the depression, could produce 670 MWe by the year 2000.[65]

Photo credit: Agency for International Development

Aswan High Dam

Solar energy and other alternative energy sources can contribute to Egypt's energy supply in the years ahead. U.S. AID funding supports a project sponsored by the National Science Foundation on solar energy in the development of an Egyptian village, mentioned above. Nevertheless, while alternative energy sources appear promising for small-scale rural applications, costly large-scale solar programs involving technology now under development would be required to contribute significantly to electricity requirements.

Egypt has limited hydrocarbon reserves. Oil exports have been used for export earnings. Production increased from 450,000 barrels in 1977 to 775,000 in 1983. Oil will probably not be used to provide a large amount of new electricity production because it is the mainstay of Egyptian export earnings. Accounting for 37 percent of export revenues in 1978 and 65 percent in 1980, it made up a remarkable 70 percent in 1981. In addition, domestic consumption of oil at highly subsidized prices is increasing at about 12 to 15 percent annually. The nation's small coal reserves, estimated at 50 million tonnes, are to be used to replace coke in the Helwan Iron and Steel Works and to fuel a 1,200-MWe power station planned in the Sinai. Coal mines at Maghara in the Sinai are also being developed to fuel a 1,200-MWe powerplant at El Arish.

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[62] Cited in U.S. Department of Energy, *Joint Egypt-U.S. Report*, vol. 1, op. cit., p. 42. The Egyptian Ministry of Electricity and Energy cites a total capacity of 4.7 GWe for 1980 in *Annual Report of Electric Statistics*, 1980, p. 8. For 1981-82, a figure of 5.0 GWe total electricity generating capacity is cited in Arab Republic of Egypt, *Electricity and Energy in the Arab Republic of Egypt*, 1983, p. 20.

[63] The three low dams could be located at Esna, Nag Hammadi, and Assiut. The four additional barrages could be located at Silsila, Qift, Sohag, and Deirot.

[64] One pump storage facility was under construction at Port Suez. K. E. A. Effat, H. Sirry, M. F. El-Fouly, E. El-Sharkawy, and A. F. El-Saiedi, *Projected Role of Nuclear Power in Egypt and Problems Encountered in Implementing the First Nuclear Plant* (Vienna: International Atomic Energy Agency, 1977).

[65] This project is being evaluated by the Swedish firm Sweco and is estimated to cost $1.2 billion, or approximately the amount Egypt plans to spend on its oil and natural gas program from 1982 to 1987.

Egypt has 203 billion cubic meters of gas reserves, which are expected to increase substantially in the next 10 years. A substantial amount of gas could be utilized for electricity generation if the 88 percent of associated gas which is currently being flared were piped to and used in thermal power plants. However, Egypt's ability to use this natural gas is severely constrained by a lack of facilities to collect and transport the gas. If Egypt's total gas production in 1980 were dedicated to the generation of electricity, about 20 percent of electricity demand for that year could be met. The Egyptians intend to use this gas for other industrial purposes, especially steel production. Egypt's situation thus contrasts sharply with that of other Middle Eastern countries where gas production is sufficient to meet all immediate and even near-term projected electrical generation needs. Gas, nevertheless, represents an important energy source, and additional gas-fired plants are planned for upper Egypt.

Even if all of the nonnuclear sources are utilized, if the Egyptian Government's projected growth rates for electricity hold, nuclear power may be used to provide a substantial fraction of generating capacity. A joint U.S.-Egyptian study completed in 1979 concluded that 40 percent of Egyptian electricity could be generated by nuclear reactors by 2000.[66] Under high electricity growth rate assumptions, Egypt could accommodate a 900-MWe reactor by 1990. Under low-growth assumptions, which appear more realistic, such a reactor could be installed and not make up more than 10 percent of the grid by 1995. Table 87 presents a summary of the range of projections

Table 87.—Range of Projected Electricity Demand in Egypt

Author	1980	1985	1990	1995	2000
Shulli (1)					
Capacity (GWe)	4.460	—	8.815	—	15.480
Production (GWh)	15,518	23,338	34,424	47,847	61,744
Egan (2)					
Capacity (GWe)	4.595	7.36	10.103	13.392	16.769
World Bank (3)					
Capacity (GWe)	3.915	6.734	9.708	13.168	(17,870)[a]
Production (GWh)	18,430	28,350	39,770	55,780	(78,234)[a]
U.S. DOE (4)					
Capacity (GWe)	—	6.954	—	—	22.036
Production (GWh)	—	27,520	—	—	88,000

[a] Calculated using the same growth rate as the previous period.

NOTE: **Assumptions of Electricity Growth—Shulli:** 1. By 2000, the gross domestic product (GDP) will be divided, with 14 percent from agriculture, 30 percent industry, 2 percent building, 12 percent transportation, 16 percent commerce and 26 percent services. (In 1977 it was: 29 percent agriculture, 25 percent industry, 4 percent building, 7 percent transportation, 13 percent commerce and 20 percent services.); 2. Population growth will be 2.4 percent from 1980 to 1985 and 2.3 percent from 1986 to 2000.; 3. GDP growth will be 8.2 percent from 1981 to 1985; 7 percent from 1986 to 1990; 6 percent from 1991 to 1999, and 4.7 percent from 1996 to 2000; 4. Electrical consumption by 2000 will be divided, with industry requiring 56 percent; housing, 21 percent; transportation, 8 percent; agriculture, 8 percent; and other, 6 percent (1975: industry, 49 percent; household, 20 percent; transportation, 2 percent; agriculture, 8 percent; and other, 21 percent); 5. Natural gas will provide 52 percent of electrical production by 2000; 6. Nuclear power will provide 2.500 MWe by 2000.

Egan: *Electricity growth assumptions:* 17 percent, 1979-80; 9.2 percent, 1981-85; 7.2 percent, 1986-90; 5.8 percent, 1991-95; 4.6 percent, 1996-2000;

World Bank: *Electrical growth assumptions:* 11.4 percent 1980-85; 7.5 percent 1985-90; 6.3 percent 1991-95.

U.S. DOE: 1. *Electricity consumption by the year 2000 will be:* 54 percent industry; 6 percent agriculture; 7 percent transportation; 7 percent public utilities; 22 percent residential; 4 percent other; 2. *Electrical growth assumptions:* 1975-85 12.7 percent; 1986-2000 8 percent.

SOURCES: 1) Abdul Rahman Shulli A., "Energy Consumption Forecast for Egypt and Sudan til the Year 2000," a paper presented at the Second Arab Energy Conference, Qatar, Mar. 6, 1982; 2) Joseph R. Egan, *Small Reactors in Less Developing Countries: Historical Analysis and Preliminary Market Survey* (Westmont, Ill.: ETA Engineering Inc., 1981); 3) World Bank, *Energy in the Developing Countries* (World Bank Paper, August 1980), background information prepared for the paper and energy analyses; 4) U.S. Department of Energy, *Joint Egypt/United States Report on Egypt/United States Cooperative Energy Assessment*, 5 vols. (Washington, D.C.: U.S. Government Printing Office, 1979).

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[66] U.S. Department of Energy, *Joint Egypt-U.S. Report*, op. cit.

of Egyptian electricity demand. Even if Egyptian electricity demand rises at a low rate, it appears that the rationale for nuclear power may remain comparatively strong in Egypt. Lower oil prices, however, enhance the attractiveness of oil and reduce the ability of the Egyptian Government to finance these projects.

In the final analysis, the ability of Egypt to develop nuclear power depends on its ability to obtain subsidized financing. Indeed, it is precisely the reluctance of the U.S. Export-Import Bank and financing agencies in other Western supplier nations that has repeatedly delayed the project. As a result, U.S. and Japanese firms teamed up in 1983 to bid jointly. Practically speaking, the politics of export financing[67] may influence Egypt's nuclear program more than the various energy-economic considerations mentioned above.

Iran's Prerevolutionary Nuclear Program

Iran's experience with nuclear power development prior to its revolution illustrates the susceptibilty of a large nuclear program to being criticized as unsound for economic, political, and infrastructure reasons.[68] While the ambitious nuclear program initiated under the Shah was ended by the new revolutionary government, criticism of the program had already begun. Iran's nuclear program was viewed by critics as grandiose and wasteful, indicating that nuclear power development is a critical choice even for oil-rich developing countries.

Iran's 1974 program called for rapid construction of nuclear plants so that 23 reactors would generate 40 percent of the nation's electricity by 2000. The Atomic Energy Organization of Iran saw its budget grow from $30 million in 1975 to $1 billion in 1976. By the end of the 1970's, the Shah's nuclear program came under direct attack by the revolutionary opposition on a number of grounds. Some criticisms focused on political factors. A small group of energy specialists and economists (from both the government and the university community) charged that a small group of foreign businessmen and advisors close to the Shah who were not competent to make technical judgments had spearheaded the nuclear program. The royal family, they said, had reaped huge commissions amounting to 20 percent of the total contracts, or several hundred million dollars per reactor.

Other criticisms, on economic grounds, highlighted the exorbitant cost overruns in the construction program. Construction costs on two planned French-built reactors grew 90 percent, interest payments included. Additional costs for consultants' fees, training, and installing reserve capacity and high-voltage transmission lines could have added several billion dollars to the cost of the first four reactors, according to some estimates. At a time when oil export revenues declined and budget trimming was required, the costs of the nuclear program became a problem. Construction by the West German firm Kraftwerk Union, however, progressed on two power reactors at Bushehr to the point where the steel dome was complete on one reactor and partially complete on the other when construction was interrupted after the revolution.

Part of the cost problem stemmed from Iran's underdeveloped infrastructure. With a shortage of reserve capacity and problems with brownouts, the additional reserve capacity to back up shutdowns of the 1,000-MWe reactors would have been extremely costly. In addition, critics worried that the Bushehr plants were not designed for a region with seismic activity. Furthermore, the water temperature and salinity of the Persian Gulf created additional design problems relating to cooling capacity and increased erosion.

Most important, perhaps, was the long distance from the Persian Gulf to the main centers of industrial electricity consumption and the inadequacy of the national grid. Enormous costs to build high-voltage lines, and inevitable transmission losses, reduced the attractiveness of plants sited along the Persian Gulf when these factors were taken into consideration. The Ministry of Power, not the Atomic Energy Organization, was responsible for transmission lines. At the end of 1977, Tavanir, the company contracted by the Ministry of Power to build the transmission and distribution network, had not yet begun construction on the 400,000-volt lines to carry power from Bushehr to other parts of Iran.[69]

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[67] Italy reportedly promised to contribute 40 percent of the cost of building a nuclear power station, according to a protocol with Egypt signed in early 1984.

[68] This discussion of Iran's debates about nuclear power is based on Bijan Mossarvar-Rahmani, *Energy Policy in Iran: Domestic Choices and International Implications* (New York: Pergamon Press, 1981), p. 105.

Despite statements by Iranian leaders, such as Rafsanjani in 1982, that Iran must promote "technical independence" and reinvigorate the Bushehr reactors, only limited budgetary allocations have been made under the revolutionary government to support these statements. The case for nuclear power in Iran has not rested on strong economic arguments in the past, nor is it likely to in the future.

The Iran-Iraq war may determine the future of the Bushehr reactors. Energy resources have been targets of Iraqi air strikes. If Iran's large hydroelectric Karun River and Dex plants were hit, the case for nuclear power might be stronger. On the other hand, the Bushehr plants might also be damaged. Most certainly any revived Iranian nuclear program would be smaller than that envisioned under the Shah. The West German firm Kraftwerk Union agreed in 1984 to conduct a feasibility study of the Bushehr site, but announced that it would not complete construction until the end of the war with Iraq.[70]

Other Nations

Prospects for nuclear power in Saudi Arabia are very uncertain. The nation has abundant oil and gas deposits, and large infrastructure projects have been scaled back in order to promote manpower development and completion of current projects. While estimates of installed electrical capacity differ widely, production of electricity has grown rapidly during the last decade. By 1985 the Saudi Arabian Government expects to have 12.4 GWe of installed capacity, not including considerable additional capacity of at least 4 GWe under the Saline Water Conversion Corporation.

Currently, there are three major disconnected load centers and several smaller disconnected regional centers. However, the Eastern Province alone has a large grid system with an installed capacity of approximately 3 GWe, and another 4 GWe under construction. (The 1980 installed capacity figure for Saudi Arabia in table 85 reflects this capacity.) Because most of this electricity in the Eastern Province is generated to desalinate water, it is possible that a nuclear reactor of 900 MWe could be accommodated by 1990. However, no firm nuclear plans have been made in Saudi Arabia.

Algeria also has no firm plans for nuclear power. The nation has a grid that connects the main population centers along the Mediterranean coast. Algeria's primary near-term option for production of electricity rests on the use of its large natural gas reserves and large existing natural gas collection and distribution system. Algeria's production of natural gas in 1980, for example, could have generated five times as much electricity as was consumed during that year. Algeria could have 4.3 GWe of installed capacity by 1990 and 10 GWe by 2000; this would be sufficient to accommodate a 900-MWe reactor not exceeding 10 percent of the grid by 2000, but not before.

Given the current financial constraints facing Algeria, the availability of electricity generation from use of its abundant gas, and the results of preliminary studies by the IAEA and SONEGAZ which indicated that nuclear power was not an economic solution for generating electricity, it is not likely that Algeria will have an operating nuclear power reactor prior to 2000.

Kuwait has a relatively large electricty grid and could theoretically accommodate a 900 MWe reactor by 1990. Despite the fact that a number of feasibility studies have been carried out, Kuwait has no definite plans for a nuclear power program. Anticipated declines in the historic rate of growth in electricity consumption and budgetary constraints indicate that Kuwait is not likely to have a power reactor until the mid-1990's, at the earliest.

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[69] *Nucleonics Week*, Feb. 2, 1978, p. 10.

[70] It was reported in December 1983 that Kraftwerk Union had signed a contract to inspect the Bushehr site. See *Middle East Economic Digest*, Dec. 9, 1983, p. 12. Kraftwerk Union spokesmen reiterated intentions to delay resumption of construction until the end of the war in communication with OTA, May 1984.

For Iraq, even more than Iran, the Iran-Iraq War provides a strong constraint on nuclear power development. Iraq's grid is much less extensive. Faced with a severe fiscal crisis and planning uncertainty due to the war effort, it appears highly unlikely that Iraq will acquire a nuclear power reactor until the war is concluded or the level of conflict significantly reduced. In contrast to the situation in Iran, Iraq's gas resources are not sufficient to provide a large portion of electricity generation.

TECHNICAL MANPOWER CONSIDERATIONS: TECHNOLOGY ABSORPTION

For all the countries of the Middle East, lack of technical manpower is a major constraint on indigenous development of nuclear power. The dilemma for developing nations is that while nuclear power often is viewed as a means to reduce dependence on foreign supplies of energy, a nuclear program inevitably increases dependence on foreign suppliers for materials, equipment, technology, and skilled manpower.

IAEA has taken the position that a systematic program for developing requisite personnel, both engineers and technicians, must precede construction of nuclear powerplants. This approach implies a long lead-time, since qualified personnel are scarce in the Middle East. Developing countries likewise have emphasized building their indigenous nuclear technological base as a means to raise the general level of scientific and technological development.

An alternative approach is to have foreign contractors build complete turnkey plants. In this case, the vendor is fully responsible for design and construction of the facility, which is operated by the vendor or by an experienced foreign firm, such as Electricité de France (EdF), working in conjunction with the vendor. The turnkey approach normally involves a degree of technology transfer, even though the buyer's staff may participate in training programs to only a limited extent during construction work. Technicians continue on-the-job training when the plant is operating. Over time, more host country personnel are trained, partly in the vendor country and partly onsite.

In sectors such as national airlines and petroleum refining there is a precedent for such a turnkey approach in the Middle East. While some argue it may limit the training of indigenous personnel, others view it as a means to eliminate manpower as a constraint on nuclear power in developing nations. The indigenous approach is more costly in the shortrun—in terms of time and human resources—than the turnkey strategy. Over the long run, however, the developing nation that has invested in building a technical manpower base is in the best position to adapt and master advanced technologies.

The discussion that follows examines the technical manpower availability and political/administrative resources of Middle East nations. These factors, in addition to the choice of an indigenous or extended turnkey strategy, determine the ability of Middle Eastern countries to absorb or fully utilize nuclear technology.

Manpower Requirements for a Nuclear Program

The nuclear industry in Western nations involves an unusually high proportion of scientific, engineering and technical workers.[71] Few countries in the Middle East have even a limited technical manpower base necessary to support a nuclear program. The exceptions are Egypt, Algeria, Iran, and Iraq--which have limited technical manpower pools.

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[71] In 1975, 49 percent of the U.S. work force in the nuclear industry was made up of scientists, engineers, and technicians. See H. Miessner, "Manpower Sources for Nuclear Power Programmes," in International Atomic Energy Agency, *Manpower Requirements and Development for Nuclear Power Programmes: Proceedings of a Symposium, Saclay, April 1979* (Vienna: IAEA, 1980). Another source indicates that the occupational distribution for U.S. nuclear powerplant workers in 1977 included 17.4 percent engineers, 35 percent technicians, and 2.8 percent scientists. See J. S. Chewning, D. L. Couchman, and G. H. Katz, "Meeting the Manpower Challenge in the Transfer of Nuclear Technology to Developing Countries," in IAEA, *Nuclear Power and Its Fuel Cycle*, Proceedings of an International Conference, Salzburg, Austria, May 2-13, 1977, vol. 6, pp. 259-272.

In examining the technical base, two kinds of considerations are pertinent. One is the quantity and quality of scientists and engineers (high-level manpower), and the other is the quantity and quality of supervisors and skilled craft laborers (technical manpower). Many developing countries in other parts of the world have found that while their scientific base is limited but adequate to support nuclear programs, the scarcity of administrative, technical and craft labor places significant constraints on the operation and maintenance of nuclear powerplants.

Leaving aside for a moment the issue of scientists and engineers, the requirements for technical laborers and supervisors are particularly great during construction of a nuclear powerplant. Construction of one 600- to 1,200-MWe light-water reactor requires 12 million to 15 million man-hours, including 10 million to 12 million man-hours of skilled labor such as welders, electricians, operating engineers, and quality control specialists. Iran imported the required manpower from the supplier country for its nuclear power construction program. There, the vendor, Kraftwerk Union, brought in most of the skilled labor and practically all of the managerial personnel from West Germany.

The bulk of technical labor requirements come during the 5 years before the start of commercial operations. For a plant of 600 to 1,300-MWe capacity, a peak work force of about 5,000 is required for plant construction and manufacture of equipment and components. Utility officials experienced in nuclear powerplant construction in developing countries conclude that first-level supervisors who have 5 to 20 years of experience are particularly important during the construction phase. In the view of U.S. officials working in an international division of a major vendor company:

> An adequate craft labor force is not a controlling factor in developing countries becoming self-sufficient, but the development of an adequate first-line supervision is. The needed skilled labor can be drawn from existing resources or by recruiting and training the available and often highly motivated resources. Single skills are quickly and readily acquired. [However,] experience has shown that nuclear power plant construction requires a significantly larger ratio of first-level supervisors to craft than is needed on other heavy construction projects.[72]

After the plant is built, about 300 to 400 workers may be needed to operate it, depending on the type of reactor.[73] IAEA spokesmen emphasize that developing nations often underestimate the requirements for highly skilled manpower needed to ensure safety and reliability in nuclear plant operations. Even for turnkey plants, there is a need for a "core of indigenous qualified manpower from the beginning of the planning for a nuclear power project."[74] In addition to requirements for scientists and engineers, about one-quarter of the operating personnel require specialized training specific to nuclear plants in areas such as radiation protection, nuclear chemistry, and operations.

The types of other personnel required are similar to those needed for an oil-fired plant, but the general capabilty of all technicians, especially the maintenance personnel, must be higher in order to ensure safety and reliability of operations. In most developing countries, additional personnel must be trained to allow for back-up and attrition, meaning that the first powerplant may demand twice as many technical personnel as a conventional powerplant of the same size. Many of those in the specialized technical category must be grounded in the basics of engineering, including computer science, while those in the second category can often be trained on the job.

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[72] David R. Zaccari, Francois R. Martel, and Eric L. Westberg, "Establishing a Nuclear Program: Some Perspectives," a paper presented at Montevideo, Uruguay, May 12, 1980.

[73] When offsite personnel are taken into account, 600 to 900 personnel may be required to operate a nuclear plant in the United States. The Connecticut Yankee 580-MWe pressurized-water reactor in 1981 had a staff of 387 onsite and 187 offsite personnel. See Lelan F. Sillin, "Management Initiatives—Manpower, " Chief Executive Workshop, Institute of Nuclear Power Operations (INPO), Sept. 1, 1981.

[74] F. Mautner-Markhof, "Manpower Development for Nuclear Power," in *Manpower Requirements*, op. cit., p. 359.

The importance of supervisory and skilled craft labor to the operation of a nuclear powerplant cannot be overemphasized. South Korea, for example, found that it had the core group of nuclear physicists needed for scientific research but lacked the welders and specialized technicians needed to build reactors. Major suppliers of reactors provide training as well as services to deal with special problems as they occur in the operation of a reactor. In a typical reactor sale, training is provided during the 6- or 7-year period between the signing of the contract and the startup of a turnkey facility.

During this period, a large number of people are trained in a wide range of skills, from graduate engineer to nondegree-holding operators. Westinghouse, for example, typically brings hundreds of local engineers who must be fluent in English to the United States for training. While the recipient may purchase simulators at a cost of $7 million to $10 million to train personnel in the host country, it is generally believed that a country should have more than one power reactor in operation to justify such an investment.

Eventually, such training programs may evolve into a means for more extensive technology transfer. Recipients wishing to acquire the ability to design and fabricate equipment and construct facilities may seek to purchase the technology itself. If the supplier agrees, licensing agreements could be worked out with the respective nuclear organizations in the host countries, and design groups from the host country might work alongside supplier firm personnel in the United States. This level of technology transfer normally occurs only after the recipient has built up considerable experience in operations and maintenance.

Based on experience in the United States, once a nuclear powerplant is built, most of the operating staff have practical training and experience but not necessarily a professional scientific education. While a developing country may have a relatively large pool of technical labor, operating and maintaining a nuclear plant requires considerable additional training in specialized areas such as health and safety, instrument calibration and repair, quality assurance, and nuclear records. As noted earlier, at least a quarter of the technical work force require specialized training in an engineering-based curriculum.

Requirements for back-up staff, and the need to bring together individuals who can work together as a team, mean that relying on indigenuous labor would be viable for Middle Eastern nations only over a long-term period. All the Islamic nations of the Middle East that seek to develop nuclear power will have to depend on foreign vendors for a considerable period of time after startup of facilities for training of personnel, spare parts, and repair. Egypt's decision to purchase its first nuclear reactors on a turnkey basis reflects a recognition that it would now be impossible to construct and operate such a facility with only indigenous personnel.

Operating a nuclear power reactor does not require a pool of research scientists trained in fields such as nuclear physics.[75] However, scientists and engineers are needed to run the regulatory and planning organizations that administer nuclear programs in developing nations. In addition, without a scientific and engineering research sector, it is unlikely that a developing nation would be able to surmount the turnkey stage of comparatively low-level nuclear technology transfer and move into independent large-scale design and fabrication of equipment, including both commercial and military applications.

Because nuclear programs require long leadtimes, and because they imply a trend toward electricity-based industrialization, the ability of highly trained scientists and engineers to work with political leaders in establishing nuclear program stability and continuity is a key requirement for developing nations. It is not enough that a country possess a large pool of academic research scientists: even more critical are individuals with specialized advanced education who can act as planners and managers. The highly trained scientists and engineers play key roles in assuring the political/administrative success of nuclear programs.

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[75] See Ian Smart, "The Consideration of Nuclear Power," in James Evert Katz and Onkar S. Marwah, *Nuclear Power in Developing Countries: An Analysis of Decision-Making* (Lexington, Mass.: Lexington Books, 1982), p. 152.

Middle Eastern Nations With Comparatively Large Technical Infrastructures

In contrast to Israel, the nations of the Islamic Middle East have limited technical manpower infrastructures. Israeli scientists, engineers, and technicians are among the best in the world, and Israel has the technical capability to support the most advanced nuclear technologies. Israel, then, is in a situation completely different from the countries of the Islamic Middle East.

Egypt.—Of all the Islamic nations in the Middle East, Egypt has the largest pool of scientists and engineers. The Egyptian Atomic Energy Establishment was formed in 1955, almost three decades ago. Even so, a lack of appropriately trained technicians precludes the possibility of Egypt developing commercial nuclear power on its own for some time. Egypt's experience is especially significant, since other nations in the region face even more severe manpower problems.

The 2,000 Egyptians at the nation's nuclear research center are far fewer than the 18,000 people included in the scientific and technical staff of the Indian Department of Atomic Energy.[76] It has been estimated that Egypt has almost 1,000 nuclear physicists with doctor's or master's degrees.[77] In 1980, the Inshas Nuclear Research Center employed approximately 2,200 people, including 500 physicists and engineers, 200 of whom held doctorates.[78] However, these scientists have been criticized for their strong academic orientation by those who would prefer that they contribute more directly to the establishment of a nuclear power program.

The Egyptian nuclear scientific community is neither well-integrated nor supported with financial resources adequate for the large nuclear program envisaged. Faced with a lack of adequate research facilities, Egyptian scientists have been forced to accept teaching positions in Egyptian or other Arab universities. The Minister of Electricity called on those scientists working abroad to return home to take part in the nuclear program, but apparently few have done so.[79]

Major decisions about nuclear power in Egypt have been taken at the highest political levels. The Higher Council for Nuclear Energy (HCNE), formed in 1975, is the formal decisionmaking body, composed primarily of politicians. President Sadat himself, in consultation with the HCNE, made the decision in 1975 to pursue a commercial nuclear power program. Critics of the program, however, include university professors and politicians from opposition parties such as the Socialist Labor Party.[80] Three state corporations possess the major responsibilities for carrying out the program, but they have been periodically reorganized, and the advice of the technical experts in these agencies has not always been heeded by politicians in making decisions. Some observers say that the Egyptian Atomic Energy Corporation, one of these three, was not fully consulted about a plan to store Austrian nuclear waste in Egypt, which was later abandoned.[81]

On rare but significant occasions, such as the opposition of people in the Alexandria area to proposed local siting of a nuclear plant, nuclear policy choices have become matters of public debate. In that case, President Sadat himself ordered suspension of siting plans after the Alexandria council passed a resolution rejecting the plant. In Egypt, where professional engineering and scientific authority has long been politically suspect, scientists and engineers have played a much less important role in giving technical advice than their numbers might suggest.[82]

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[76] See Richard P. Cronin, "Prospects for Nuclear Proliferation in South Asia," *The Middle East Journal*, vol. 37, No. 4, autumn, 1983, p. 597, for figures on Indian personnel.

[77] Mohammad El-Sayed Selim, "Egypt," in Katz and Marwah, op. cit., p. 152.

[78] Louise Lief, "Egypt Reviews its Stance as MidEast Nuclear Arms Swell," *Christian Science Monitor*, Aug. 18, 1980. See also U.S. DOE, *Joint Egypt-United States*, vol. 5, op. cit., p. 17.

[79] See Selim, op. cit., p. 153 and Abdel-Gawad Sayed, "The Reality of the Arab Nuclear Capability," *Al-Mustabkbal Al-Arabi*, January 1980, p. 162, (translated and quoted in Selim).

[80] Ibid., p. 148.

[81] Ibid., p. 147.

Iran.—In comparison to Egypt, other Middle Eastern countries face even more severe constraints on nuclear technology transfer by virtue of their small technical manpower pools. In Iran, where the Institute of Nuclear Science was established in Teheran in 1958, it is doubtful that the revolutionary government will be able to launch a new nuclear program based on "indigenous technical expertise," as the head of the Isfahan Nuclear Technology Center has advocated.[83] Owing to political, social, and economic dislocations of the revolution and the war with Iraq, a revised Iranian nuclear program would have to start off with only a fraction of the prerevolutionary technical base.

In the 1970's, hundreds of Iranian students were trained in the United States and Europe in nuclear-related fields, but many of these technicians and scientists fled from Iran during the revolution. The revolutionary government has passed legislation encouraging them to return, offering the incentive that their property holdings will be guaranteed. However, there is no evidence that this group has returned. Iran's technical manpower base is thus currently weaker than it was prior to the revolution. Therefore, despite recent indications that Iran's leaders have begun to consider completing the Bushehr power reactors, it appears that inadequate local manpower will remain a constraint, particularly if Iran should emphasize a program based on independent development of nuclear power.

Iraq.—Iraq has committed itself to a nuclear research program and has acquired a number of operating research reactors and a laboratory-scale reprocessing facility. It is impossible to gauge precisely the number of Iraqi nuclear scientists and engineers, but they number far fewer than those in Egypt. Currently, education and training in nuclear fields is limited to undergraduate studies in Iraq, and for the foreseeable future Iraq will depend on foreign countries such as France and Italy for training.

Italy agreed to train 100 Iraqis in the fuel cycle labs they provided, and the French agreed to set up a "nuclear university" at Tuwaitha to train 600 scientists and technicians. While information concerning the quality of current programs is not available, these assistance programs have not been officially discontinued in the post-Osirak period. The combined impacts of the Iran-Iraq War and Saddam Hussein's imprisonment of members of the nuclear community have resulted in a setback to the nation's nuclear program.[84]

Iraq, through a technical cooperation agreement with Brazil, is acquiring training, uranium exploration technology, and engineering services. Because Brazil is not a signatory to the NPT and the country has received nuclear technology from West Germany, West Germany negotiated a bilateral nonproliferation provision with Brazil which extended safeguards over West German technology retransferred by Brazil. While it appears that Brazil did not transfer any West German know-how, Brazil's position as an importer of Iraqi oil raised concerns about the possibility that Iraq might receive sensitive technologies from Brazil not covered in the Brazil-West Germany accords.[85]

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[82] For a discussion of the limited role technical advisors played in the decision to build the Aswan Dam see Clement Henry Moore, "The Politics of Technical Consultation," *Images of Development: Egyptian Engineers in Search of Industry* (Cambridge, Mass.: MIT Press, 1980), pp. 156-165.

[83] See "Esfahan Nuclear Technology Center Reactivated," reported in JPRS, *Nuclear Development and Proliferation*, No. 138, Apr. 14, 1982, pp. 26-27.

[84] See U.S. Congress, Senate, *Analysis of Six Issues About Nuclear Capabilities of India, Iraq, Libya and Pakistan* (Washington, D.C.: U.S. Government Printing Office, 1982); and *New Scientist*, Aug. 28, 1980), p. 635. See also Richard Wilson, op. cit., for a report on a visit to Tuwaitha in early 1983.

[85] See "Brazil and Iraq Signed a Nuclear Cooperation Agreement," *Nucleonics Week*, vol. 21, Jan. 17, 1980, p. 10.

Other nations such as West Germany and Sweden have agreements with Iraq that include training; however, it appears that far fewer Iraqi students have studied nuclear engineering in Western countries than have Egyptians and Iranians. In 1981-82, for example, the Institute for International Education Survey showed that five Iraqi students were studying nuclear engineering in U.S. universities, four at the graduate level.[86] Iraq's cooperative agreements with the Soviet Union are still valid, and the number of Iraqis trained in the Soviet Union is considered to be significant.

Algeria.—In Algeria a nuclear research organization was set up in the mid-1960's, and education in physics, chemistry, and nuclear engineering is available through the undergraduate level. Algeria's Center for Nuclear Technology and Science (CNST) is developing a broad-based nuclear science research program that provides Algeria with the fourth largest pool of nuclear manpower in the Middle East. The center has research divisions working on uranium ore processing, fuel fabrication, reactor engineering, nuclear physics, applied nuclear research, and health physics. It employs 170 scientists and has a total staff of 500. CSTN spends an estimated $9 million annually and operates two Van de Graaf accelerators (3 Mev and 2 Mev).[87]

Algeria has tentative plans to build a nuclear research center at Ain Oussera, but no announced plans to expand graduate-level education at the new technical universities that are to be built. As a result, most advanced training in nuclear fields takes place outside Algeria, in Western nations. The nation has technical cooperation agreements with Belgium, Brazil, and France.

In years past, the Soviet Union provided some limited nuclear assistance, but there is no indication that significant cooperation still occurs. Given the extreme limitations to training programs for advanced technicians and the absence of a formal decision by Algeria to emphasize nuclear technology acquisition, it appears that Algeria might develop the manpower base required to operate nuclear reactors built on a turnkey basis and the skills needed to support limited uranium mining—all by the turn of the century. However, advanced training will entail foreign study for the next 20 years.

Limited Technical Infrastructures in Other Middle East Nations.—In contrast to Egypt, Iran, Iraq, and Algeria where a small technical infrastructure exists, Libya and other Middle Eastern nations have much more limited technical manpower bases. In Libya, despite a high-level political decision to acquire nuclear technology, mixed results have been achieved—owing primarily to the reluctance of foreign suppliers to involve themselves and to Libya's comparatively late start in the early 1970's. Unable to acquire technology from many Western nations, Libya has relied primarily on the Soviet Union and Belgium.

The Tagiura Nuclear Center near Tripoli was built with Soviet assistance and a 10-MWt research reactor, fueled with approximately 3 kg of 80 percent enriched uranium, was provided. This reactor went critical in late 1981 or early 1982, but reportedly experienced some start-up difficulties.[88] Libya has received assistance from the Belgian firms Union Mirac and Belgonucleaire for uranium exploration and fuel fabrication. It is also negotiating with the Soviet Union for a 440-MWe reactor, which would probably be imported on a turnkey basis using skilled labor from Bulgaria and Yugoslavia. As mentioned earlier, a Belgian firm may participate in the power reactor project.[89] Given its lack of facilities for advanced study in nuclear fields, Libya will be dependent on study programs abroad, particularly in Eastern bloc nations, for many years to come.

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[86] Institute of International Education, "Detailed Cluster Report on Nuclear Engineering," correspondence, Feb. 1, 1983.

[87] See "Cooperation is the Key to Arab Nuclear Development," *Nuclear Engineering International*, January 1982, p. 14. See also, papers by Adnan Mustafa and Adnan Shihab-Eldin for the Second Arab Energy Conference, Doha, Qatar, Mar. 6, 1982.

[88] See Zivia Wurtele, Gregory S. Jones, Beverly C. Rowen, and Marcy Agmon, *Nuclear Proliferation Prospects for the Middle East and South Asia* (Marina Del Ray, Calif.: Pan Heuristics, 1981).

[89] Robin Miller, "Nuclear Plans Outlined," *Jamahiriyah Review*, No. 22, March 1932, p. 17. See footnote 9.

This discussion underscores the weakness of the nuclear technical manpower base in the Islamic nations of the Middle East. All of them, except Iran under the revolutionary government, have publicly committed themselves to a strategy of near-term reliance on foreign suppliers rather than attempting a purely "indigenous" route. (And in Iran it is doubtful that the rhetoric can be translated into practice.) Because of their limited technical infrastructures, none of these nations can construct, fuel, operate and maintain nuclear powerplants without considerable foreign assistance at this stage.

Bilateral Nuclear Cooperation

Nuclear technology transfer, particularly the training component, has occurred most often in a bilateral context. Normally, governments establish bilateral nuclear cooperation agreements that open the door for commercial sales and training programs. The United States has established bilateral agreements for nuclear cooperation with a number of Middle Eastern nations. A bilateral agreement was signed with Iran in 1957, and a revised agreement was negotiated but not signed prior to the revolution in Iran. The United States provided technical assistance though its Atoms for Peace Program.

Under that program, a total of about 230 people from Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, and Saudi Arabia were trained. More than half were Egyptians, and the total number of trainees was far smaller than that for countries such as India (1,104) or Taiwan (713).[90] The United States has a few programs in the nuclear field with Israel; the Nuclear Regulatory Commission (NRC) has a 5-year agreement to exchange nuclear safety and environmental information with Israel.[91]

The most important bilateral agreement in the nuclear field with any country in the Islamic Middle East is the one with Egypt. In 1981, the United States and Egypt signed a full nuclear cooperation agreement that contains strict provisions concerning controls and safeguards. Programs sponsored under this agreement have included special attention to safety issues. Egypt's decision to ratify the NPT and its willingness to accept bilateral controls opened the way for more extensive technology transfers. The bilateral agreement between the United States and Egypt has thus contributed to U.S. nonproliferation policies.

Many other supplier nations have also established nuclear cooperation agreements with Middle East nations. Bilateral cooperation agreements provide the assisting nation with a measure of influence over the nuclear program of the recipient in exchange for helping the recipient develop indigenous technical capabilities. The inability of the U.S. Export-Import Bank to finance Egyptian reactor sales is seen by some as evidence that cooperation is limited, posing a significant problem for Egypt's leadership.[92]

Middle Eastern Students in the United States

As discussed in chapter 13, foreign student enrollment in U.S. educational institutions may be an important channel for technology transfer. To date, comparatively few Middle Eastern students have been enrolled in technical fields, but this pattern is likely to change as those students who first came to the United States in the late 1970's begin to consider advanced graduate training.

An increasing number of engineering graduates from the 30 U.S. institutions which offer degree programs in science and engineering are foreign nationals. The Federal Government has not collected data on the exact numbers of Middle Eastern students by fields of study enrolled in such U.S. programs, but of the almost 62,000 foreign nationals who received science and engineering doctorates between 1960 and 1981, there were 1,600 Iranians, 500 Iraqis, and almost 1,400 Egyptians. About one-third of these degrees were awarded during 1960-81 in engineering, of which about 1,000 were awarded to students from Iran, Iraq, and Egypt. These numbers are far smaller than the numbers of students from the East Asian region (about 15,000) who earned similar degrees during the period.[93]

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[90] See U.S. Congress, Joint Committee on Atomic Energy, *S. 1439: Export Reorganization Act of 1976*, hearings, 94th Cong., 2d sess.; Mautner-Markoff, op. cit.

[91] U.S. Congress, Committee on Science and Technology, *Science, Technology and American Diplomacy* (Washington, D.C.: U.S. Government Printing Office, 1982), p. 174.

[92] See G. Henry M. Schuler, "Will Egypt Be Denied its 'Peace Dividend?' " *American-Arab Affairs*, No. 7, winter 1983-84.

In 1981 alone, 189 Iranians, 26 Iraqis, and 77 Egyptians were awarded doctorates in all science and engineering fields from U.S. institutions. In the more specialized fields of nuclear engineering and physics, fewer Middle Eastern students received degrees. Table 88 shows numbers of doctoral degree recipients from these nations for 1981. Middle Eastern students make up only a very small percentage of student enrollment and doctoral recipients in science and engineering. According to data collected by the Institute for International Education, during 1981-82 there were about 20 Middle Eastern students enrolled in nuclear engineering programs.[94] These data are inadequate indicators of Middle Eastern study in technical fields, however, because a doctorate is not a prerequisite for an engineer to function effectively in most developing country projects.

The small number of Middle Eastern students enrolled in and receiving Ph.D.'s in technical fields contrasts sharply with enrollments in all programs. In 1981-82, 326,300 foreign students were enrolled in various programs of education in the United States. Among this group, 74,390 students were from the Middle East. The largest number (35,860) were from Iran, followed by 10,220 from Saudi Arabia, 6,800 from Lebanon, 6,180 from Jordan, and 3,330 from Kuwait.[95] The enrollment of foreign students from the Middle East grew very rapidly during the 1970's. However, only a small number of these students were studying subjects such as nuclear engineering. With the exception of Iran under the Shah, there is little evidence of a directed effort by any Middle Eastern nation to train a large number of students in nuclear engineering or in related disciplines in the United States.

In 1983, the Reagan administration issued an order forbidding Libyan students to study nuclear engineering or aviation in the United States. However, officials in the State Department and the Immigration and Naturalization Service were unable to verify estimates that 2,000 students from Libya were actually enrolled in all U.S. programs, much less how many were pursuing studies in nuclear engineering or civil aviation. In August 1983, deportation hearings began for nine Libyan students whose visas had expired.[96] The only other instance of such restrictions on foreign students from the Middle East occurred during the time of the hostage crisis, when an investigation was conducted to verify the legal status of Iranian students studying in the United States.

Nuclear technology transfer also occurs through the IAEA. U.S. contributions totaling $5 million in 1981 supported the IAEA's Program for Technical Assistance for Safeguards. This organization carries out training programs in nuclear manpower development in a variety of fields. The organization estimates that its programs have trained about 40 percent of the personnel needed by developing countries.[97] During the 4-year period 1975-78, fewer than 100 people from the Middle East were trained in IAEA programs, with the largest numbers coming from Egypt (23) and Iran (27).

IAEA has forecast that no Middle Eastern nation will attain the highest stage of capability ("self-sufficiency") in nuclear technology by the year 2000. Also, even under extremely optimistic assumptions concerning growth in nuclear power, only Egypt and Iran might at-

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[93] National Science Foundation, *Science and Engineering Doctorates: 1960-81*, NSF 83-309, p. 68.

[94] Data provided by the Institute for International Education, January 1983.

[95] Institute of International Education, *Open Doors: 1981/82* (New York: IIE, 1983), p. 18.

[96] "Libyan Students Held as Risks Freed on Bail; Deportation is Expected," *New York Times*, Aug. 14, 1983.

[97] S. B. Hammon, and M. A. Kanter, "Nuclear Power: Project Training for Engineers from Developing Countries," *Engineering Education*, January 1982, p. 316.

Table 88.—Middle Eastern Students Receiving Doctorates in Technical Fields in the United States, 1981

Country of origin	Ph.D.s engineering	Physics and astronomy
Iran	74	13
Iraq	4	1
Jordan	8	1
Kuwait	3	0
Lebanon	8	2
Saudi Arabia	15	0
Syria	1	1
Algeria	4	0
Egypt	41	1
Libya	5	1
Total Middle East	163	20
Total non-U.S. citizens	1,241	715
Taiwan	201	37

NOTE: It is difficult to determine where these students will go after receiving their degrees; data is collected well before graduation. Out of 13 students receiving Ph.Ds in physics and astronomy, for example, 3 planned to stay in the United States, 2 planned to return to West Asia, and 8 had not made plans when the survey was taken.

SOURCE: Data provided by the National Science Foundation, August 1983.

tain the level of a "confirmed" program with two or more plants in operation.[98] While many of these countries are developing nuclear research programs, the quality of these programs varies, and only Egypt and Algeria have established programs that could be considered indigenously based. Given these factors, it appears highly unlikely that any of these Islamic Middle Eastern nations except Egypt will be a position to undertake a reactor project indigenously before the turn of the century, unless there are dramatic shifts in policy.

MILITARY APPLICATIONS CONSIDERATIONS

The Middle East is generally viewed as a part of the world where nuclear weapons would be particularly dangerous because of its history of political turbulence and conflict. Tension exists not only between Israel and its Arab neighbors, but also between other states in the region (Iran and Iraq, Egypt and Libya) and within states. The introduction of nuclear weapons could affect the region's balance of power. Moreover, the Middle East is strategically important to the superpowers, whose interests would be affected by the spread of nuclear weapons in the region. U.S. ability to influence events there could be substantially reduced if weapons proliferation reduced the willingness of nations in the region to cooperate with the United States or to exercise restraint in their military programs.

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[98] B. J. Csik, "Manpower Requirements for Nuclear Power in Developing Countries," in IAEA, *Manpower Requirements*, op. cit., p. 18.

It seems unlikely that nuclear proliferation in the Middle East would be a stabilizing influence. Arguments about stabilization have been based on the assumption that some states would have a second-strike capability, but the possibility that any country in the region except Israel could develop such a capability in the next 20 years appears remote. In addition, given Israel's stated intention not to allow any states in the region to develop a nuclear explosives capability—and its destruction of Iraq's Osirak reactor—the spread of nuclear weapons is almost certain to elicit response by major states in the region.

The analysis that follows leads to the conclusion that because of shortages of skilled manpower and the restrictive export polices of supplier nations, most Middle Eastern nations will be unable by themselves to construct nuclear weapons until well into the next century. Nevertheless, political variables will strongly influence the course of nuclear proliferation in the region. If one nation were to demonstrate its ability to use a nuclear device, other nations might try to catch up. Similarly, if supplier nations (including countries such as India and Argentina that are likely to emerge as suppliers) loosened restrictions on nuclear exports, proliferation would become more likely.

Intentions

While a host of technological, manpower, and financing considerations affect the spread of nuclear weapons, political considerations are paramount. Political factors that stimulate proliferation include the perception that Israel has the technical capability to produce nuclear weapons in a short period of time. It is likely that, barring a lasting peace settlement, the major motivation for weapons acquisition by other countries in the region will be as a deterrent to Israel.

A second factor involves concern that a country's weapons capability is on a par with that of other Islamic countries in the region. Syria's increased interest in nuclear technology may, for example, be due in part to concern about Iraq's program. If Libya acquires a militarily significant nuclear weapons capability, Egypt might reevaluate the direction of its nuclear program.

Nuclear cooperation among nations in the region could, under certain conditions, accelerate weapons proliferation. Reported contributions by Middle Eastern nations to Pakistan's nuclear program could be motivated by a desire to obtain nuclear technology or by the wish to ensure that the other contributors will not obtain an advantage. Overt proliferation by any state in the region would undoubtedly stimulate activity by others. Finally, if the export policies of supplier nations (including smaller nuclear states likely to become suppliers) become more lenient, the incentives for weapons acquisition will increase.

Pace and Nature of Nuclear Proliferation in the Middle East

Despite incentives for weapons acquisition, overt proliferation has not occurred. Inhibiting political factors include safeguards and the reluctance of major supplier states to provide sensitive technologies. The perceived fear of the consequences of weapons proliferation, especially for small states and those dependent on geographically clustered industrial or oil facilities, has most certainly acted to limit nuclear weapons acquisition.

Another major factor limiting nuclear weapons programs has been the domestic politics of Middle Eastern nations: political leadership has not been strong enough to sustain steady development of commercial nuclear programs, much less to launch highly focused crash weapons programs. Nevertheless, the persistence of deep and costly conflicts such as the Iran-Iraq War might propel leaders to attempt to steal or fabricate unsophisticated nuclear weapons.

While the existing nuclear weapons states developed their weapons in programs dedicated wholly or substantially to military purposes, and while these nations proved their capability through testing, it appears that latent proliferation in conjunction with small research-scale facilities is the most likely path for nations in the region. (Indeed, Israel's assumed capability is based on comparatively small-scale facilities.) This is the case because, as mentioned earlier, most of these countries are not likely to acquire commercial-scale sensitive facilties and because of the nonproliferation controls of supplier nations.

While it is theoretically possible for a state to purchase nuclear-grade graphite or heavy water and attempt to design and build its own plutonium production reactor and a facility for extracting the plutonium, such a project would be difficult for nations with such weak technical infrastructures. In addition, a weapons program that includes facilities such as those listed above would involve substantial importation of equipment and, for all nations except Egypt, of technical personnel; it would be apparent to outside observers that a program was under way.

Given these factors, the most worrisome path to weapons capability is the acquisition of small-scale fuel cycle facilities that can be rationalized, more or less reasonably, as logical components of an orderly long-term effort to develop a broad capability for using nuclear power.

India represents an extreme example of this path. Some of its power reactors are safeguarded, but not all. India acquired unsafeguarded research and materials-testing reactors, pilot-scale reprocessing plants, and heavy-water production facilities in the 1960's, with substantial assistance from foreign companies and governments. Buying these facilities probably cost considerably less than would have construction of commercial-scale plants. A program of this type, using research reactors, could be comparatively inexpensive—on the order of $300 million.[99]

Libya.—Among the Islamic nations of the Middle East, only Libya has made an overt effort to acquire nuclear weapons, although there is strong circumstantial evidence that Iraq has attempted to equip itself with necessary facilities. If these nations are categorized as those with "high intentions," most of the Islamic Middle Eastern nations should be viewed as having medium or low intentions, based on nuclear technology trade patterns and policy positions.

Despite Libya's well-advertised intentions to acquire nuclear explosives and its willingness to use oil money to purchase any type of nuclear technology possible, its nuclear ambitions are severely limited by the weakness of its technical manpower base and lack of coherent planning and research programs. As a result, it is unlikely that Libya will be able to achieve nuclear independence at India's level for 30 years.

Libya's overt designs on nuclear weapons have made supplier nations reluctant to sell. Colonel Qaddafi's request for sensitive nuclear technology, and worldwide concern over Libyan-Pakistani nuclear cooperation, prompted the French government of Giscard d'Estaing to cancel an agreement to sell Libya a 600-MWe reactor in 1975. Libya also failed in its attempt to obtain "tactical" nuclear weapons from China in the early 1970's and to acquire Indian nuclear explosives and production technology in the latter part of the decade.

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[99] Various estimates have been made of the cost of moving to the first nuclear bomb test for a nation with no reactor or nuclear base. These estimates are reviewed in Gordon W. Smith and Ronald Soglio, "Economic Development and Nuclear Proliferation: An Overview," in Dagobert L. Brito, Michael D. Intriligator, and Adele W. Wilk, *Strategies for Managing Nuclear Proliferation* (Lexington, Mass.: Lexington Books, 1983), pp. 75-76. The authors conclude that the economic costs are less a constraint than the "policy costs" to less-developed countries of moderate income and population which are determined to acquire nuclear weapons.

Through financial assistance to Pakistan, Libya attempted to obtain sensitive nuclear technology, but relations between the two nations cooled after the fall of Prime Minister Bhutto and under pressure from the United States.

Of greatest current concern are reports that Niger has sold at least 788 tons of uranium to Libya, some of which may have been shipped to Pakistan, thus circumventing IAEA safeguards.[100] These sales apparently were ended in 1981, but the transactions raise a number of problems. The uranium could be stockpiled for use in an undeclared facility located either in Libya or abroad. Currently, Libya's ability to acquire sensitive nuclear technology depends to a great extent on the policies of the Soviet Union. If Soviet exports become less restrictive or new suppliers enter the market, Libya's ability to acquire technology might increase. However, it is striking that the Middle Eastern nation most committed to a nuclear weapons path has been so unsuccessful in acquiring sensitive technology.

Iraq.—The case of Iraq illustrates many of the difficulties in assessing the proliferation potential of individual nations. Although Israel justified destroying the Iraqi Osirak reactor in 1981 on the grounds that " . . . it is intended, despite the camouflage, to create atomic bombs," U.S. Government officials stated that the U.S. intelligence community had not firmly concluded that Iraq was, in fact, planning to build a weapon.[101]

Public attention has focused on the possibility that Iraq was pursuing a "quick-fix" rapid weapons building effort, when it appears more likely that the primary thrust of Iraq's program was to acquire nuclear facilities and experience needed to produce nuclear weapons some years down the line after expiration of its bilateral accords with the French. The covert and latent nature of the proliferation potential of Iraq underscores the importance of examining the long-term implications of technical infrastructure building.

At the heart of debates about Iraq's ability to produce a nuclear weapon are questions of the effectiveness of safeguards. Because Iraq is a party to the NPT, concern about potential Iraqi nuclear weapons proliferation has highlighted uncertainties about the coverage of safeguards. Iraq's record of nuclear technology acquisition has led many to question whether a nation might pursue a weapons program while publicly adhering to the NPT, and later abrogate the NPT when it is convenient to do so.

Evaluation of Iraq's future ability to produce nuclear explosives requires an examination of the proliferation scenarios considered credible prior to the bombing of the Iraqi reactor. One scenario involved Iraq acquiring sufficient highly enriched uranium (HEU) to make a bomb. Using the IAEA definition of a "significant quantity" of uranium needed for a nuclear weapon, Iraq would have had to obtain 25 kg of HEU in order to construct a nuclear device. Concern focused on the HEU supplied to Iraq for its two research reactors. France initially agreed to supply 70 kg of 93 percent HEU. HEU of this type could have been used directly in the production of nuclear weapons. This amount would have been sufficient for production of several nuclear devices, but IAEA safeguards and the presence of French technicians onsite would have made diversion difficult, though not impossible.

Debates ensued within the French Government about whether caramel, or low enriched uranium, should be supplied as a substitute. Such uranium would have to have been further enriched in order to produce HEU. Ultimately, Iraq rejected this caramel option and the French decided on a compromise plan that involved shipments of HEU in consignments of about 12 kg, sufficient for a core-loading reactor but insufficient for weapons manufacture, as the reactor was to be operated continuously.[102]

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[100] It is not clear whether shipments planned for 1981 were completed. If they were, the total shipped would have amounted to about 2,000 tons. See "Libya Buys Uranium Secretly," *The Times*, London, Aug. 29, 1981, p. 4.

[101] See Roger Pajak, op. cit., pp. 53 and 56. For a review of the evidence concerning an Iraqi nuclear weapons program, see Jed C. Snyder, "The Road to Osirak: Bagdad's Quest for the Bomb," *Middle East Journal*, vol. 37, No. 4, autumn 1983, p. 587.

After the destruction of Osirak, the French promised to assist Iraq in rebuilding the Osirak reactor but French spokesmen reportedly called for strengthened safeguards and the use of low-enriched uranium fuel in the rebuilt reactor. Iraq opposed this, some believe, on the grounds that it did not meet the conditions of the original contract and that the neutron flux resulting would have been lower and inadequate for certain types of research operations.[103] No agreement has been reached at this point, and fuel shipments from France apparently have not occurred. Nor has the Tammuz 1 Osirak reactor been rebuilt.

The second major diversion scenario involved the production of plutonium for a nuclear device. This diversion path would not be eliminated with the supply of caramel fuel. Osirak could have been used to produce plutonium by irradiation of uranium targets in the reactor core or by installation of a uranium blanket around the core. According to IAEA sources, removing the reflector elements from the reactor and irradiating fertile elements both inside and outside the core could provide up to one or two "significant quantities" of plutonium per year, or approximately 8 kg.[104] French physicists estimated that the reactor could produce 3.3-10.0 kg per year; however, the actual amount is dependent on the plutonium production scenario.

In a "core" scenario, uranium targets could be placed in the reactor core and irradiated. Tammuz 1 was designed as a materials testing facility; such a facility in industrialized countries is for studying irradiation of power reactor construction materials and fuel elements. Substituting uranium would not have been difficult because of in-core inspection limitations. The procedure might have been difficult to detect given the short irradiation time (weeks) required. However, the core size limits the amount of uranium that can be irradiated, making plutonium production cumbersome. In order to gain 8 kg of weapons-optimal plutonium, 8,000 to 10,000 kg of uranium would have to be irradiated.[105]

The IAEA could have detected this activity through existing safeguards techniques, but sufficient time passes between inspections to allow the production of some plutonium. With the presence of French technicians and substantial improvements in IAEA inspection techniques under consideration, detection would have been highly probable.

The second scenario for plutonium production requires a natural or depleted uranium "blanket" to be placed around the reactor core. The length of irradiation is a function of the neutron flux—that is the density of neutron emission from the reactor core. Since the blanket is outside the core, and therefore farther away from the core, there is less neutron flux and irradiation time is longer. In addition, greater cooling capacity would probably be necessary to remove the excess heat generated by irradiation of the blanket. Despite these constraints, much more uranium could be irradiated at one time. The probability of detection would depend on how easily the blanket was installed and removed. However, once again, with French technicians present and IAEA surveillance cameras operating, this scenario could have been detected with existing safeguards techniques.

If Iraq had succeeded in irradiating uranium, it would have obtained plutonium, but reprocessing limitations would have diminished the prospect of near-term accumulation of significant quantities of plutonium. The small laboratory provided by the Italians would have permitted reprocessing on only a small scale.

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[102] The French also reportedly irradiated the HEU, making it much more difficult to use in weapons production. Irradiated HEU would have to be reprocessed in order to make it usable in nuclear weapons; capabilities to do so would have been limited by the small size of Iraq's reprocessing laboratories.

[103] "France, Iraq Unveil Secret Nuclear Accord," *Energy Daily*, June 19, 1981. "More Nuclear Guarantees From Iraq to be Sought," *Le Monde*, Jan. 18, 1982, p. 7, reported in FBIS: France. See also Andrew Lloyd, "Can France Stop the Iraqi Bomb?," *New Scientist*, Apr. 22, 1982, p. 201, for a report on French debates on the caramel option.

[104] Hans Gruemm, "Safeguards and Tamuz: Setting the Record Straight," *IAEA Bulletin*, vol. 23, No. 4, December 1981.

[105] Less optimal plutonium with 0.2 percent concentration would require irradiation of 4 tonnes (metric tons) of uranium. The light-water reactor design is not a very "convenient" path to plutonium production because it does not produce the spare neutrons necessary for a high rate of plutonium production.

Both of these plutonium production scenarios are constrained by technical factors and safeguards. For a country with Iraq's limited technical manpower base, indigenous plutonium production would have been difficult. During the nearterm, the presence of the French and the application of safeguards, as well as the international attention focused on Iraq, would have made diversion of HEU or modified usage of the facility unlikely unless Iraq withdrew from the NPT.[106]

However, the thrust of Iraq's program may have been acquisition of nuclear weapons over the longer term. Given the presence of French technicians until 1989, it seems likely that the goal was to build up a technical capability over the near term, leaving open the option for weapons production after the departure of foreign advisors and the development of a group of highly trained Iraqis. This long-term scenario, requiring 15-20 years, would eventually provide Iraq with the ability to develop a nuclear arsenal rather than a few unsophisticated bombs. While some believe it may have set the program back, Israel's raid on the research reactor thus did not eliminate the long-term possibility of an Iraqi weapons program since technical assistance in reprocessing-related technology continues. More important in diminishing longer term proliferation prospects is the combined effect of the Iran-Iraq War and the reported imprisonment of members of Iraq's nuclear community.

Before the reactor is rebuilt, a number of issues will have to be worked out. The French have expressed their intention to extend safeguards and to "internationalize" the project by insuring that the new administrative scientific director would be a Frenchman or a representative of the IAEA. External Relations Minister Cheysson has stated that French assistance will be resumed only with the "doubling or quadrupling" of safeguards.[107]

The case of Iraq illustrates the possibility that with combined improvements in fuel and facility design and in safeguards, the threat of proliferation could be substantially reduced while retaining a legitimate nuclear program. Three changes could enhance this possibility. First, reduced enrichment fuels (caramel or silicide) now under development might be used in research reactors presently fueled with HEU. The use of low-enriched uranium fuel, if it could be fabricated to maintain the neutron flux of HEU, could serve nonproliferation goals.[108] Second, a new research reactor could be designed to make the installation of a blanket outside the core virtually impossible. Finally, better remote-sensing and inspection techniques could upgrade the quality of safeguards.

Iran.—While it is difficult to ascertain the intentions of the Khomeini regime in Iran concerning nuclear weapons, it appears that the pressures of warfare with Iraq may limit Iran's ability to engage in a crash weapons program. At the same time, its motivations for doing so may be increased. A sudden upgrading of Iraq's program might stimulate reevaluation by Iran. It appears that the current regime, like that of the Shah, may emphasize acquisition of sophisticated conventional weapons. The acquisition of nuclear weapons would be seen as provocative by the Soviets. In addition, a restart of Iran's nuclear program would be impeded by the flight of scientists and engineers from the country following the revolution.

Syria.—Syria was apparently as concerned about the development of Iraqi and Iranian nuclear capability as Israel was. Syria's approach to nuclear development reflects a desire not to fall too far behind any of the other Islamic nations in the region. Consequently, setbacks to any of the other programs may mitigate Syrian proliferation prospects, particularly if Israeli capability remains undemonstrated. Syria's important step has been to develop plans for commercial reactors and scientific research facilities, and Syria's military expenditures have been concentrated on maintaining the front against Iraq and Israel and on local interventions in Jordan and Lebanon. The Soviet Union, Syria's major military supplier, apparently has not provided Syria with sensitive nuclear technology. Syrian capability to produce a nuclear explosive device indigenously will probably not develop until the turn of the century.

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[106] If the French had been willing to cover up illegal actions by the Iraqis, a prospect feared by Israel, the possibilty of detection would have been significantly reduced.

[107] "Nuclear Supplies to Iraq Dependent on Tougher Safeguards, France Asserts," *Nucleonics Week*, vol. 22, No. 26, July 2, 1981, p. 1.

[108] However, this results in the production of more plutonium. In addition, some experts question whether lower-enriched uranium fuel could be used so as to maintain a high enough neutron flux needed for cutting edge experiments.

Egypt.—Egypt has a greater technical capability than any other Middle Eastern Islamic nation to develop nuclear weapons if such a political decision were made. However, its nuclear technology purchases indicate that no steps have been taken in this direction, and the nation is generally not considered to be a proliferation threat at present. Egypt rejected a proposal in the early 1960's for a 200-MW natural uranium-fueled, heavy-water reactor that could have produced a large amount of plutonium. The nation currently has no fuel fabrication plans and has concluded that an indigenous enrichment program would not be cost effective. Egypt has little research relating to the front end of the fuel cycle, and no known R&D program related to uranium enrichment.

Although the argument has been made that Israel still may pose a major threat to Egyptian security, Egyptian leaders have said little about Israel's nuclear capability since the Camp David accords. Whether because Egyptians have chosen a strategy of conventional preemptive attack or because the perceived threat has diminished, Egypt's acceptance of the NPT indicates an emphasis on a long-term strategy designed to develop the technological foundation for a nuclear power program. After acquiring a large amount of commercial nuclear technology and considerable experience, Egypt could, of course, move toward a nuclear weapons option later if the political choice were made to do so.[109] However, in order to do so Egypt would have to acquire sensitive facilities.

The development of nuclear weapons by Libya, if this were to occur, could seriously alter Egyptian thinking about the nuclear weapons path. Likewise, if Israel demonstrates nuclear capability or is perceived as having expansionist rather than status quo intentions, the pressure to develop nuclear weapons would be increased in many Islamic nations, Egypt probably included.[110]

Algeria.—Algeria's limited nuclear infrastructure precludes indigenous production of a nuclear device until the end of the century. Because Algeria has been moving closer to the West and is unlikely to experience a geopolitical change sufficient to cause it to initiate a crash weapons program, it does not appear that Algeria has made the decision to pursue a weapons path. It could, however, build a broadly based program which could form the foundation for a nuclear explosives program in the 21st century. The nation has not signed the NPT; therefore, in order to import nuclear technology, Algeria may be forced to accede to safeguards. If Algeria exported uranium, it would be under no legal obligation to require safeguards, a situation that could raise proliferation concern in the next century.

Saudi Arabia.—Saudi Arabia currently has no significant nuclear research facilities or nuclear power plans. However, since the Saudis have the capacity to finance programs in other nations, they are important in the context of Middle Eastern nuclear weapons proliferation. Saudi Arabia has a strong interest in the stability of the Middle East and therefore is likely to view weapons development programs in other states as alarming. It could support regional and global efforts to reduce Israel's incentives to adopt an overt nuclear stance; for example, participation in the nuclear programs of other nations could be directed at enhancing Saudi Arabia's capability to limit the spread of nuclear weapons technology in the region and to ensure the peaceful orientation of such programs.

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[109] An editorial written by the editor-in-chief of *Al Ahram* advocated ratification of the NPT on precisely these grounds. See Selim in Katz op. cit., p. 156.

[110] See CSIS, op. cit., p. 56.

Some believe that Saudi Arabia may have provided financing for Pakistan's nuclear program in order to preclude exclusive cooperation between Pakistan and either Iraq or Libya. Assistance to Iraq for reconstruction of its reactor could be given in such a way as to restrain Iraq from producing weapons. Another method would be to emphasize regional security interests through organizations such as the Gulf Cooperation Council as a counterbalance to unilateral weapons production programs in individual states.

Other Limiting Factors

For Middle Eastern nations wishing to pursue a nuclear weapons path, gaining sufficient weapon-grade fissionable materials (with all the accompanying technical expertise required) presents a more serious constraint than does weapons design or delivery. As Middle Eastern nations develop the technical manpower and industrial infrastructure to produce independently weapons-grade nuclear materials, the design and fabrication of simple, low-yield (10- to 20-kiloton) fission weapons will also become feasible. Assuming that such weapons would weigh as little as 1,000 pounds—much less than those first produced by the United States—delivery using aircraft already in the region would be possible.

Therefore, if Middle Eastern nations are able to produce nuclear weapons, they will probably also be able to deliver them with a moderately high probabilty of success, at least against their immediate neighbors. With small air forces, limited numbers of bases, and limited air defense capabilities, such delivery systems are, however, likely to be quite vulnerable to destruction by preemptive attack, either conventional or nuclear. Given the technical difficulty and additional expense required, initial nuclear capabilities are not likely to be of a "secure second-strike" character.

One final issue is the expense of nuclear weapons programs. Based on historical data, a small **dedicated** nuclear weapons program would cost about $300 million annually.[111] Such an expenditure would, of course, be more feasible for the richer oil-producing nations, but it would not be prohibitive for many countries in the Islamic Middle East. Four countries—Iran, Iraq, Egypt, and Saudi Arabia—could operate such a program over 10 years at a cost less than 3 percent of their annual defense budgets.

Table 89 provides cost estimates of a dedicated program for each of the countries, using average annual defense expenditures for the 1970-79 period as a baseline for calculations. Historically, no nation that has developed a nuclear weapons program has spent more than 3 percent of its annual defense on such a program.[112] Some nations of the region could certainly spend more than this amount, but it is quite possible that bureaucratic infighting among military leaders would result if the program were seen to be jeopardizing improved conventional capabilities. As table 89 indicates, the economic constraints would be much greater for phase 2 and 3 programs, which include dedicated delivery systems and development of a secure second-strike capability.

These conclusions should not, however, be interpreted to indicate that there is little cause for concern about nuclear weapons proliferation in the Middle East. In the years ahead, as new suppliers enter the market it may well be that developing countries determined to obtain nuclear weapons will be able to acquire the required technical assistance and sensitive facilities more easily. This is a major theme of the section which follows. In addition, political variables will continue to weigh heavily in determining the prospects for proliferation. If one nation in the region were to demonstrate its nuclear capability, this would probably

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[111] Estimates are based on costs of the Indian Phase 1 program and include costs of heavy-water and nuclear-grade graphite. See Thomas W. Graham, "The Economics of Nuclear Weapons in Nth Countries," in Brito, et al., op. cit., pp. 16-18.

[112] Stephen Meyer, *The Dynamics of Proliferation* (Cambridge, Mass.: Ballinger, 1983).

Table 89.—Hypothetical Cost of Dedicated Nuclear Proliferation Program for Selected Countries

Country	Average annual defense expenditure (1970-79)	Percent of defense budget Phase 1 ($300 million)	Phase 2 ($2 billion)	Phase 3 ($5 billion)
Algeria	447	6.7	44.7	111
Egypt	1636	1.8	12.2	30
Iran[a]	7596	0.4	2.6	7
Iraq	1811	1.6	11.0	28
Jordan	236	12.7	84.7	212
Kuwait	716	4.1	27.9	69
Lebanon	97	30.8	205.0	514
Libya	418	7.1	47.8	119
Morocco	478	6.2	41.5	105
Oman	530	5.7	37.7	94
Qatar	718	4.1	27.8	70
Saudi Arabia	6802	.5	2.9	7
Syria	—	—	—	—
Tunisia	67	44.0	297	742
North Yemen	107	27.9	186	465
South Yemen	55	53.7	350	896
UAE	187	15.9	106	266
Selected countries of proliferation concern				
Argentina	1245	2.4	16.0	40
Brazil	1785	1.6	11.2	28
India	3111	1.0	6.4	16
Israel	3361	0.9	5.9	15
Pakistan	913	3.3	21.9	55
South Africa	1410	2.1	14.1	35
South Korea	1739	1.0	11.4	29

[a] Data for rerevolutionary Iran.

NOTE: Phase 1: Acquisition of a few fission devices, based on plutonium (includes both demonstrated and "bomb in the basement" type programs).
Phase 2: Acquisition of a thermonuclear weapons capability, with a dedicated aircraft delivery system.
Phase 3: Development of a secure second-strike capability.

SOURCES: U.S. Arms Control and Disarmament Agency, *World Military Expenditures and Arms Transfers, 1970-1979* (Washington, D.C.: U.S. Government Printing Office, 1982); Thomas W. Graham, "The Economics of Producing Nuclear Weapons in Nth Countries," in *Strategies for Managing Nuclear Proliferation*, Brito, et. al. (eds.) (Lexington, Mass.: Lexington Books, 1983).

stimulate weapons programs in other states. Military conflict and political disputes in the region thus heighten the danger of proliferation.

Even if a nuclear weapons program were made a matter of highest national priority, no Islamic country in the region is now capable of producing a nuclear device on a wholly indigenous basis within this decade, and most would have difficulty doing so before the turn of the century. Therefore, while political and military conflicts continue in the region, the weak technical capabilities of these nations reduce their ability to obtain weapons-grade materials in domestic facilities and to produce nuclear devices. Egypt, the nation with the strongest technical manpower base, might be in position to independently produce a nuclear weapon by the end of the 1990's if policies were changed to emphasize development of sensitive technologies. With the assistance of foreign experts willing to work in clandestine programs, however, the technical manpower constraints to independent weapons production could be significantly diminished in these Middle Eastern countries.

SUPPLIER COUNTRY APPROACHES TO NUCLEAR TECHNOLOGY TRANSFER

Because Middle Eastern countries have limited nuclear infrastructures, the possibility for and rate of proliferation will be strongly influenced by the amount and kind of external assistance provided by supplier nations. The policies of the major nations supplying nuclear technology worldwide--the United States, Great Britain. Canada, France, West Germany, Italy, Belgium, Switzerland, the Soviet Union—range from a reluctance to sell any nuclear materials to countries in the Middle East to a willingness to sell sensitive facilities under IAEA safeguards. It is not likely, because of treaty constraints and domestic political decisions, that any of the current suppliers would sell any type of unsafeguarded nuclear facility to the region.

Nevertheless, the types of small-scale facilities and the nature of training and technical assistance they are willing to provide will affect the rate at which Middle Eastern nations develop indigenous capabilities to absorb nuclear technologies—both for commercial and military purposes. It is much more difficult to anticipate the policies which may be developed by new suppliers such as Argentina, Brazil, and India, which may enter the market in the years ahead. While the "new" supplier nations all have limited capabilities to produce nuclear techonologies and are not likely to export until the 1990's, the fact that they are not parties to the NPT, and therefore not under obligation to require safeguards on the export of nuclear materials or equipment, makes their policies of particular concern.

U.S. POLICIES

While different U.S. administrations have placed emphasis on different nuclear nonproliferation policy issues, American policies in practice have precluded the sale of unsafeguarded facilities or even sensitive safeguarded facilities, such as enrichment or reprocessing plants, to any Middle Eastern country. U.S. sales of major nuclear items such as reactors or fuel have generally been made only to countries accepting full-scope safeguards on their facilities. It appears likely that nuclear exports by U.S. firms will remain comparatively limited to fuel, power reactors, or research reactors.[113] It is not only these treaty and legislative obligations but also bipartisan American leadership in international nonproliferation efforts that indicate continuation and strengthening of policies designed to limit nuclear proliferation. Amendments to the Export Administration Act passed separately by both the U.S. House of Representatives and Senate in 1983 and 1984 would, if enacted, widen the definition of prohibited nuclear export items.

In addition, lower dependence of the United States on Middle Eastern oil nations reduces the possibility that oil leverage could be used to cause serious modificiation to these policies. U.S. firms such as General Electric and Westinghouse have emphasized sales of fuel cycle services, such as fuel fabrication and spare parts, rather than reactor sales. Therefore, while the subdivisions of these companies producing reactors would obviously benefit from increased reactor exports, the firms are not solely dependent on reactor sales. U.S.-made research reactors are technically and financially competitive on international markets, but in most cases require supplies of 25-percent enriched uranium. In addition, since 1977, Congress has reviewed all nuclear technology sales involving financing by the Export-Import Bank, with the result that exports of nuclear technologies financed by the bank have declined in recent years.[114]

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[113] U.S. policies do not preclude assistance to nations not parties to the NPT, and in recent months nonsensitive spare parts have been provided to such nations in an effort to keep a dialogue open with them, according to administration officials. See, for example, statement by Richard T. Kennedy before the Subcommittees on International Security and Scientific Affairs and International Economic Policy and Trade, House Foreign Affairs Committee, Nov. 1, 1983.

One type of proposed legislation would extend export restrictions to a broad variety of dual-use items, primarily computers. This legislation would prohibit sales of any dual-use items to nations not signatories to the NPT. Another type of proposed legislation which gained wider support in the 98th Congress would expressly prohibit sales of nuclear components and technology to nonsignatories. (In the view of proponents of the legislation, the fact that such sales are permitted while sales of major nuclear items are prohibited amounts to a "loophole" which should be closed.)

The United States has the most comprehensive export control system covering nuclear equipment and technology of any supplier nation. However, controversy has arisen as to how this system can be strengthened. Recent changes in the policies of the Reagan administration, such as those loosening controls on reprocessing by friendly nations such as Japan, have no significant or direct impact on the nuclear programs of Middle Eastern nations.[115] However, critics worry that this "discriminatory" nuclear export policy represents a general softening in policy and leaves the door open for reclassification of some developing nations as not being proliferation risks and therefore as potential buyers of sensitive U.S. facilities at some time in the future.

On the other hand, under the Reagan administration countries such as Iraq, Libya, and Israel, suspected of developing nuclear weapons, have been added to the list of nations requiring specific U.S. Department of Energy authorization for exports of sensitive nuclear technology by U.S. firms.[116] As noted earlier, some advocate widening the scope of exports barred to non-NPT signatories (to additional nuclear items, or to a broad array of dual-use items). In neither case is it clear that the prohibitions would, if enacted, have strong or immediate impacts on the nuclear programs of nations in the Islamic Middle East.[117] Currently, about 6 percent of U.S. dual exports go to these nations, and other suppliers are capable of providing both the dual-use and additional nuclear items of concern.[118] U.S. firms are not now major suppliers of nuclear technology to nations of the Islamic Middle East which are nonsignatories to the NPT. On the other hand, in the view of proponents of the proposed legislation, dual-use exports can be critical to nuclear programs and strengthened prohibitions on nuclear and dual-use trade with countries that have not accepted full-scope safeguards and are likely to themselves become suppliers of nuclear technology in the years ahead could contribute to U.S. nuclear nonproliferation policies.

POLICIES OF OTHER WESTERN NATIONS

A number of nations such as Great Britain, Canada, Australia, and Japan, will probably maintain their comparatively restrictive policies on nuclear exports. Great Britain has not sold a nuclear reactor to any country for a number of years, and its longstanding nonproliferation policies preclude sale of unsafeguarded or sensitive nuclear facilities in the Middle East. Canada and Australia are not likely to provide assistance to any Middle Eastern nation that has not accepted full-scope safeguards.

Canada has recently reversed its previous policy of no nuclear sales to any Middle East nation. Therefore, sales of CANDU reactors, heavy-water production plants, and technology to nations covered by safeguards are possible. Canada has ongoing negotiations with Egypt and Kuwait, and is marketing a 600-MWe reactor.

Japan has not yet substantially entered the nuclear export market but has the capacity to do so. However, it does not appear likely that Japan would make its first independent foreign sale in the Middle East. Mitsubishi, in a joint bid with Westinghouse to market in Egypt, may provide nonnuclear equipment.

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[114] Export-Import Bank of the United States, *Report to the U.S. Congress on Export Credit Competition and the Export-Import Bank of the United States,* December 1982, p. 27. In 1981, authorizations for nuclear power-related exports totaled $212 million, out of $1.3 billion for all energy-related exports. The Export-Import Bank supported no authorizations for nuclear exports in 1982. See, *Report to the U.S. Congress,* 1983.

[115] See Harry R. Marshall, Jr., "The Challenge of Nuclear Technology," *State Department Bulletin,* September 1982.

[116] "DOE Moves to Expand List of Nations Needing Special O.K. for Nuclear Deals," *Inside Energy,* July 2, 1982, p. 4.

[117] Effects on U.S. exports would be more significant. During the July 1981-June 1982 period, Israel imported $102 million worth of dual-use equipment, while Saudi Arabia's imports were valued at $179 million. See General Accounting Office, *Controlling Exports of Dual-Use, Nuclear-Related Equipment.* GAO/NSIAD-83-28, Sept. 29, 1983, p. 8.

[118] GAO, ibid. Israel and Saudi Arabia, both nonsignatories to the NPT, are among the largest single-country importers of dual-use technologies from the United States.

The Japanese Ministry of Trade and Industry initiated a feasibility and design study for a 200 to 300 MWe reactor, indicating a potential role for Japanese firms later in the century.

For a number of years, West Germany has opposed the adoption of a blanket requirement for full-scope safeguards by members of the London Suppliers' Group.[119] While West Germany has not sold reprocessing facilities to other countries since 1977, and has announced it will not sell reprocessing plants, it did sell heavy-water production technology to Argentina, a country which has not accepted safeguards on all of its nuclear facilities. West Germany has a strong nuclear power industry, and its firms are likely to remain important competitors in world markets where firms like Kraftwerk Union make large proportions of their sales. Its ban on exports of reprocessing equipment reveals a commitment to nonproliferation policies, but the Germans have carried through with controversial agreements to provide Brazil with sensitive facilities. The Brazil-West Germany agreement does, however, extend comparatively strict safeguards on German technology. The West Germans have adhered to the guidelines of the Nuclear Suppliers Group (NSG),[120] but government spokesmen have also said that the specific situation of each importing country should be taken into account, along with provisions of the NPT in nuclear exports.[121]

In the past, France has exported sensitive facilities; the nation is not a party to the NPT. However, its agreement to the NSG guidelines suggests that it will continue to require IAEA safeguards, but probably not full-scope safeguards, to nations that receive French nuclear assistance. France, like other exporters, is under pressure to export because its reactor production facilities are not utilized to capacity. The most likely Middle Eastern export candidate is Egypt, where negotiations for two reactors are well advanced. French Government and business officials closely coordinate their export negotiation efforts, and talks have been held with nations such as Iraq, Morocco, and Algeria concerning possible reactor sales.

It is not clear whether the French will sell reprocessing facilities to Middle Eastern nations in the future, though they have announced they will not do so and have not signed contracts for export of sensitive facilities in recent years. French commercial considerations have been at least as prominent in French export policies in years past as nonproliferation issues. In certain instances, however, they have exercised restraint: France withdrew from a contract to provide Pakistan with a reprocessing plant owing to concerns about Pakistan's alleged effort to develop nuclear explosives.

France may well refrain from selling commercial-scale sensitive facilities to Middle Eastern nations. In addition, French experience with Iraq's research reactor has led it to move toward more stringent requirements on research reactor exports. However, France's lack of insistence on full-scope safeguards and the commercially oriented nature of its nuclear export policies are issues of concern from a proliferation standpoint.

Belgium and Italy provide nuclear assistance that is not directly required for near-term development of commercial power for peaceful purposes. Both of these nations have supplied such technologies to nations of particular proliferation concern—Libya and Iraq. Belgonucleaire has provided Libya with fuel fabrication technology and is considering supplying technologies that could be of concern if Libya were to obtain centrifuge technology from Pakistan or to develop an indigenous enrichment program.[122] The Italian Nuclear Agency (Comitato Nazionade per l'Energiie) has provided Iraq with considerable nuclear assistance, including a range of laboratory-scale reprocessing facilities.

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[119] All of the Western supplier nations discussed here are members of the London Nuclear Suppliers Group, which was set up in the mid-1970's at U.S. initiative. The members have individually and unilaterally agreed to control exports of nuclear technologies on the "trigger list."

[120] The NSG has made an important contribution to extending IAEA safeguards and to standardizing the conditions for acquisition of sensitive technologies.

[121] Joseph Pilat and Warren Donnelly, "Policies for Nuclear Exports, Cooperation and Non-Proliferation of Seven Nuclear Supplier States," CRS Report No. 82-100 S, May 1982, p. 24.

[122] "Libya and Belgonucleaire of Belgium are in Detailed [Talks]," *Nucleonics Week*, vol. 23, Dec. 2, 1982, p. 4.

In neither case is the type of assistance being offered "sensitive" in the sense that it can lead directly and quickly to the development of a nuclear weapons capability, but it will provide Libya and Iraq with precursor technology that would make it easier for either nation to take such a step in the future. As noted above, neither Libya nor Iraq is today in a position to develop such technology on an indigenous basis, but the assistance contributes to the development of their technical capabilities. The position taken by Italy and Belgium, both parties to the NPT, is that their assistance is being provided under safeguards, and there is no indication that safeguards are being violated. Given the stated interest of Libya, in particular, in developing nuclear weapons, the United States has viewed this assistance as a matter of concern.

SOVIET POLICIES

The Soviet Union is a party to the NPT and has historically been a strong supporter of a comprehensive nonproliferation regime, to a great extent due to its experience with the spread of nuclear technology to China. It has advocated full-scope safeguards, participates in the London Suppliers Group, has not assisted recipients in developing complete fuel cycle technologies, and has insisted that spent fuel from reactors it has supplied in Eastern Europe be returned to the Soviet Union. The Soviets, for example, strongly encouraged Libya to sign the NPT, which it did.

There are, however, some who argue that Soviet nonproliferation policy may become less unified and strict in the years ahead. The Soviet Union and Eastern European nations that manufacture nuclear equipment may see it as both politically and economically advantageous to expand exports to Middle Eastern developing countries, thus gaining hard currency and perhaps some political leverage. Moreover, a loosening of U.S. nonproliferation resolve might act to diminish that of the Soviets.

The signs of Soviet policy change are far from clear, however. Moscow's dealings with Libya illustrate the point. The Soviet Union concluded its cooperation agreement with Libya only after that nation had ratified the NPT, and waited to expand assistance until full-scope safeguards were instituted. The Soviet Union shipped 11.5 kg of HEU to Libya just before the full-scope safeguards went into effect, a fact that some view as a sign of loosening of controls and that others see as a technicality. In addition, the Soviet Union continues to supply Libya and other nations with HEU instead of developing fuels of lower enrichment. Observers note that it is not yet certain whether or not the Soviet Union will require Libya to return spent fuel rods, but it has done so in other cases thus far.

Some experts worry that Soviet nuclear export policies are in flux and point to the destabilizing effects on the Middle East if Moscow should move toward a more commercially or politically oriented nuclear assistance stance.[123] It does not appear likely that Soviet policies will shift sharply and rapidly, but even a gradual diminution in proliferation resolve would be a matter of serious concern in the context of the Middle East. For Libya and Syria, the Soviet Union is the major force determining the nature and extent of nuclear technology acquisition. However, there is little concrete evidence that Soviet nuclear export policies have changed.

NEW SUPPLIER STATES

While it may be correct to assume that none of the major suppliers listed above will provide Middle Eastern nations with unsafeguarded sensitive technologies needed for weapons development, a major question is whether the "new" supplier states likely to enter the market in the years ahead will follow the same policy. Several countries such as Argentina, Brazil, India, Pakistan, and South Africa have already engaged in a limited amount of international nuclear commerce or have the potential to do so. None of them have signed international treaty agreements requiring them to place safeguards on their exports.

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[123] Tyrus W. Cobb, "Small Nuclear Forces: Soviet Political and Military Responses," paper prepared for the Georgetown Center for Strategic and International Studies and the Defense Nuclear Agency, September 1982.

The People's Republic of China (PRC) refused to give Egypt nuclear weapons technologies in the early 1960's and more recently refused Libya's requests for nuclear weapons or sensitive nuclear technologies. While China reportedly assisted Pakistan with sensitive nuclear technology, it does not appear that any Middle Eastern nation is likely to provide a quid pro quo of advanced conventional military technology, as Pakistan is capable of doing. The PRC has also provided limited amounts of basic nuclear training to countries in the Middle East; however, it has recently joined the IAEA, and its participation in safeguards programs is expected.

Both Brazil and India have been pressured by Iraq and Libya, respectively, to provide nuclear materials and technology, but in both cases no sensitive technology was transferred. Thus new suppliers have exercised some restraints, indicating willingness to support some parts of the nonproliferation regime. It was no coincidence that as Iraq found itself increasingly unable to buy nuclear technologies from major Western suppliers it turned to Brazil, a nation purchasing 40 percent of its oil from Iraq. Brazil's response was measured. The nation diversified its oil imports and concluded an agreement with West Germany ensuring that no retransfer of West German technology to Iraq would occur.

Nevertheless, concern remains that Iraq might receive uranium hexafluoride (a feed material for enrichment) and relatively primitive centrifuge technology from Brazil since they are not covered in the Brazil-West Germany Accord. While Brazilian officials deny that they have supplied Iraq with uranium, the nuclear cooperation agreement signed with Iraq in 1979 calls for a supply of uranium, joint research and experimentation, uranium exploration technology, finished fuel elements, equipment and engineering services for reactor construction.[124] The policies of new supplier nations like Brazil will be extremely important in determining the prospects for Middle Eastern nuclear proliferation.

Libya turned to Pakistan with requests for nuclear technology when France tightened up its policies on nuclear exports. Countries such as Libya and Saudi Arabia have reportedly contributed financially to Pakistan's nuclear program, with Arab credits valued at $1 billion extended to Pakistan for various purposes during the 1974-76 period.[125] Pakistan is high on the list of nations of nuclear proliferation concern. Reports that Pakistan was building a small clandestine reprocessing plant and that the nation had assembled a small enrichment plant through purchases of specialized equipment ostensibly destined for other projects indicate the nation's steps down the path toward nuclear weapons capability.

Some have argued that because of Islamic traditions, as well as growing economic interaction between Pakistan and the oil-producing states of the Gulf, Pakistan is the most likely candidate to retransfer nuclear technology to the Middle East.[126] Despite reports of Arab financial contributions to Pakistan, there is no evidence that Pakistan has transferred sensitive nuclear technologies. It has not been a major supplier of nuclear technologies to any Middle Eastern nation, and has made assurances to the U.S. Government that it will not transfer sensitive nuclear technology. It appears that relations between Libya and Pakistan cooled after the ouster of Prime Minister Bhutto.

The most important potential "new" supplier of nuclear technology to the Middle East may be India. With its comparatively broad nuclear and industrial base, and its expanded foreign policies in the region, India may play a greater roie in the years ahead. Indeed, in

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[124] "Brazil and Iraq Signed a Nuclear Cooperation Agreement," *Nucleonics Week*, vol. 21, Jan. 17, 1980, p. 10.

[125] Pajak, op. cit., p. 68.

[126] Steve Weismann and Herbert Krosney, *The Islamic Bomb* (New York: Times Books, 1981).

1979 it signed an agreement to provide Libya with sensitive nuclear technology.[127] The Indian nuclear scientists who were to be involved in the transfer objected, and Libya responded by terminating a 2 million-ton oil contract with India. After a period of strained relations, Libyan scientists began training in India in less sensitive areas such as theoretical nuclear studies, reactor operations, and medical applications.

This incident illustrates that despite considerable oil leverage exerted by Libya, India apparently refrained from transferring sensitive technologies. Thus, it would be a mistake to assume that Third World solidarity (or other factors such as common religious heritage) will necessarily dictate the policies of the new supplier states. Nevertheless, the potential for proliferation increases as new suppliers not parties to the NPT enter the market.

CONCLUSIONS: THE FUTURE OF NUCLEAR TECHNOLOGY TRANSFERS TO THE MIDDLE EAST AND OPTIONS FOR U.S. POLICY

FUTURE PROSPECTS FOR NUCLEAR TECHNOLOGY TRANSFERS

No Islamic Middle Eastern nation is in a position to carry out a commercial reactor program on a wholly indigenous basis during the next decade, and most will not have the capability in the year 2000. The major constraints on commercial nuclear power development in the region include a shortage of appropriately trained scientists, engineers, and skilled craft workers; an absence of interconnected electricity grids; and the disincentive provided by the presence of alternative sources of energy. As indicated in table 86, only Egypt, Iran, Kuwait, and Saudi Arabia might be able to install a 900 MWe power reactor not exceeding 10 percent of their electricity grids by the year 1990.

Nations that choose a turnkey plant strategy can minimize the salience of manpower constraints, but this implies continuing dependence on foreign suppliers. Egypt is the Middle Eastern nation with the strongest rationale for a commercial nuclear program and with the largest technical manpower base to support one, but Egypt has decided to import turnkey plants and to rely on foreign assistance for some years to come.

Developing countries in the Middle East may expand nuclear research programs in the years ahead, even in the absence of commercial nuclear power programs. Such research is viewed by many developing countries as essential for building their indigenous technological infrastructures, permitting more effective use of imported technologies.[128]

Acquisition of commercial light-water reactors without sensitive nuclear facilities poses no direct or significant threat of weapons proliferation. However, even small-scale reprocessing facilities (components of peaceful research programs) could be used (albeit with difficulty) to produce plutonium for nuclear weapons.

The Middle Eastern nation that has most outspokenly stated its ambitions to carry out a nuclear weapons program, Libya, also has an extremely limited technical infrastructure, which will force it to continue to depend on foreign suppliers for many years to come. Egypt, and perhaps Iraq, may have the technical capability needed to produce a nuclear device in the next decade. (In the case of Egypt, the agreement to safeguards and the emphasis on acquisition of nuclear technologies needed for a peaceful nuclear power program indicate an absence of intention to do so.)

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[127] Argonne National Laboratory, *World Energy Data Systems, Country Data: Libya*, vol. 3, 1979.

[128] See Michael J. Moravcsik, "The Role of Science in Technology Transfer," *Research Policy*, 12 (1983), pp. 287-296, for an elaboration of this point.

For nations of the Middle East, financing and delivery systems do not present great obstacles to development of small weapons programs. More important are manpower constraints (particularly in the near term) and political factors, including the policies of supplier nations.

Overt proliferation has not occurred in the Middle East. One major explanation is surely that the suppliers have not been willing to transfer sensitive technologies without adequate safeguards. Thus, the nonproliferation regime through which suppliers limit their exports has been the major factor influencing the pace and nature of proliferation in the region. This analysis underscores the critical importance of the "new" supplier states and the need to bring them into the nonproliferation regime. Incentives for latent proliferation can be expected to persist and grow, however, and safeguards cannot fully guarantee that facilities are used for peaceful purposes.

Assuming that the current situation continues and disputes between Israel and its Arab neighbors and among Islamic countries are prolonged, the possibility of nuclear weapons proliferation may increase in the Middle East during the next 20 years. There are two reasons for this pessimistic conclusion: 1) the new supplier states may be more willing to transfer sensitive technologies, and 2) nations in the region will gradually improve the technical manpower and infrastructures required to support weapons programs. Unless a nuclear device is actually used, most of the nations in the region will probably move slowly toward developing expertise and importing facilities needed to start a weapons program. Nevertheless, technological advances such as development of laser isotope separation would increase the potential for nuclear weapons proliferation.

While it is impossible to anticipate the way in which nuclear weapons proliferation might occur, there are a number of possibilities. A new supplier state might provide sensitive and unsafeguarded facilities, perhaps in exchange for oil supply guarantees. The reluctance of both Brazil and India to succumb to such pressure exerted by Iraq and Libya suggests that the new suppliers would probably have to perceive a significant threat to their security interests to do so. Likewise, the policies of one of the major Western nations or the Soviet Union now supplying nuclear technologies might change, permitting freer transfer of sensitive nuclear technologies.

Still another possibility is that nations might accelerate their progress down the path to nuclear weapons production through joint programs, perhaps involving some of the newer supplier states. On the other hand, it is difficult to imagine which nations might forge a political alliance strong enough to support such a joint program over a number of years. In addition, it is not clear which suppliers might be induced to participate, even under the guise of a peaceful program.

A nation or nonstate group might try to purchase or steal a nuclear device. However, nations such as Libya have failed in their attempts to do so. In addition, detonation of a single nuclear device is unlikely to provide the long-term deterrence or defense capability required.

The most likely pattern for nuclear proliferation in the Middle East may, therefore, be a slow and indirect path. Given the technical dependence of most of these nations, they may choose to develop their technical manpower bases and import nuclear technologies that can be justified as parts of a peaceful nuclear program, thus increasing their capabilities to institute a weapons program sometime down the road if they make the political decision to do so. Assuming that suppliers continue to require IAEA safeguards, however, the probability would be high that covert weapons production programs could be detected.

U.S. POLICY OPTIONS

OTA's analysis of nuclear technology transfers to the Middle East indicates that while

U.S. leadership in establishing the nonproliferation regime has been important, only a limited number of policy options are available and even fewer exist that the United States could introduce unilaterally with significant effect.

Options that the United States could adopt unilaterally include an extension of restrictions on Government-supported financing of nuclear exports by the U.S. Export-Import Bank. Export-Import Bank support for nuclear sales has declined sharply in recent years, and this is seen by many as contributing to the reduced overseas sales of reactors by U.S. firms.[129] However, sales of turnkey reactors do not by themselves pose a nuclear weapons proliferation risk, and they contribute only indirectly and over a very long time to building a technical manpower base in developing nations. U.S. firms may form partnerships with foreign firms and seek financing elsewhere. Another possibility might be to selectively subsidize reactor sales to countries that accept stringent nonproliferation restrictions. In this case, nuclear technology would be used as a reward to countries that agree to certain political conditions.

Second, the United States could move to limit the number of foreign students admitted to nuclear physics and engineering programs. However, only in the case of Iran under the Shah have large numbers of Middle Eastern students been enrolled in such U.S. programs. In view of lack of precise information about what foreign students are studying, it would be difficult to implement such restrictions. Moreover, because of the apparently small number of Middle Eastern students currently enrolled in such programs, it appears that U.S. leverage is not strong. Associated questions of the freedom of American academic institutions would certainly be raised, and developing countries in other parts of the world might react negatively. Finally, since foreign students are free to enroll in programs in other supplier nations, U.S. restrictions would not severely restrict their ability to study in these fields unless other supplier nations instituted similar restrictions.

A more positive type of approach that the United States could independently pursue would be an extension of nuclear cooperation agreements with other Middle Eastern nations, similar to that with Egypt. In many respects, the U.S.-Egyptian nuclear accord represents a model by virtue of its detail and the strength of safeguard provisions. One argument in favor of extending such accords is that the offer of assistance to a developing nation might be more persuasive than the threat of denial of U.S. technologies. However, in order for cooperation agreements to be perceived by the recipient as significant, real assistance must be provided, resulting in the recipient's developing greater technical capability. Cooperation agreements of this type are most easily negotiated with nations having close relations with the United States. Failure to follow through with cooperative efforts or inconsistent policies (e.g., those limiting financing of U.S. nuclear exports to Egypt) can lead to frictions which may diminish the importance of the agreements.

The United States could also make greater efforts to assist nations in developing alternative energy sources and to help them assess the feasibility of nuclear power. Of the possible alternatives or supplements to nuclear power in the region, the role of indigenous natural gas and the potential for greater efficiencies in energy-use merit further analysis on a country-by-country basis. Such assistance should be viewed as strongly contributing to U.S. nonproliferation policies. Those who oppose U.S. assistance to commercial nuclear power programs would welcome expanded efforts to develop alternative energy sources in these countries.

A number of other policy options would require coordination with other suppliers. One approach would be to continue support for the development of low-enriched uranium fuels in programs such as the Argonne National Laboratory research and test reactor (RERTR) program. In addition, study of the plutonium production potential of research reactors should be promoted so that technical refinements could be introduced that would make it difficult to misuse such reactors. Because risks of proliferation are smaller when research reactors with a capacity of less than 10 MWt and fueled by low-enriched uranium are used, other suppliers could be encouraged to provide such types of research reactors. Nations such as the Soviet Union could also be encouraged to provide only low-enriched uranium fuel.

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[129] These restrictions do not prohibit U.S. firms from turning to foreign governments for financing. In late 1983, it was announced that Westinghouse and the Japanese firm Mitsubishi had decided to bid jointly on the Egyptian reactor contract, presumably with financing provided by Japanese banking institutions.

In addition, a very important contribution would be to clarify the upper bounds on hot cells and other fuel cycle facilities and to establish limits on their export. The United States could also make a major effort to develop and maintain a consensus among suppliers that they not assist in the development of capabilities that will permit Middle Eastern nations to separate kilogram quantities of plutonium per year from irradiated fuel. Similarly, the United States could encourage formation of a consensus not to export enrichment technologies to the region. Such efforts could be combined with a willingness to cooperate with Middle Eastern nations in nuclear power and civilian research programs.

The United States can continue to promote strengthened safeguards, such as the use of remote sensing in reactor cores and more frequent inspections. While critics have pointed out the potential weaknesses of safeguards, the safeguards system contributes to the identification of potential proliferators. It is unlikely that international safeguards can be substantially strengthened outside the IAEA and the NPT. The IAEA is the major international working organization involved in nuclear training and technology transfer, and the U.S. must participate in order to influence its programs.

In the past, the United States has encouraged nations to sign the NPT. In the Middle East, a number of key nations including Algeria, Israel, and Saudi Arabia have not signed the treaty. It may be difficult to persuade Saudi Arabia to sign the NPT unless equal pressure is placed on Israel. In the case of Algeria, Soviet and French support would be critical, and French nonaccession is a definite liability in this respect. Agreement by the countries of the region to a nuclear test ban treaty could also limit the prospects for detonation of a nuclear device.

Policy options open to the United States are thus limited, and most of those likely to achieve significant results require the cooperation of other nations supplying nuclear technology. It is clear that Middle Eastern countries no longer regard the United States as the world's dominant supplier of nuclear technologies, and that a number of them may develop nuclear power for peaceful purposes in the years ahead. It is therefore essential that U.S. energy and nonproliferation policies stress multilateral efforts to reduce the spread of nuclear weapons.

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Patterns in Technology Transfer: Impacts and Experiences

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CHAPTER 10

Patterns in Technology Transfer: Impacts and Experiences

INTRODUCTION

Transfers of advanced civilian technologies can have significant effects, positive and negative, on both recipients and suppliers. Because technology transfer is a complex process, assessment of impacts requires consideration of the interrelationship between technology transfers and major social, economic, and political changes. As discussed in chapter 2, evaluations of "success" inevitably depend on rankings of the political, economic, and social criteria used in evaluation. Assessment of the impacts, or the effects of complex processes such as technology transfer, is necessarily inexact and tentative. Analyzing experiences with civilian technology transfers to the Middle East during the past decade is nevertheless essential because it provides insights useful to U.S. policymakers as they develop policies affecting technology transfers in the years ahead.

The purpose of this chapter is to compare and contrast findings concerning impacts across sectors and countries. The major questions include the following: Have technology transfers of certain types been particularly conducive to technology absorption? Have the experiences of various recipient and supplier nations differed significantly? Have the effects of these civilian technology transfers been generally favorable or adverse for suppliers and recipients? The impacts discussed here include those related to technology absorption by recipients, as well as other economic, political, and social effects important to suppliers and recipients.

The effects of technology transfer are more readily assessed at the firm or sector level than at the national level. This is because these effects depend on the content of the technology transfer, and because the changes in capability that result are most apparent in the recipient firm—its efficiency of operations and the skills of its personnel. This chapter compares and contrasts impacts of technology transfers in commercial aircraft support systems, telecommunications systems, medical services, petrochemical production facilities, and nuclear power production. The extent of technology absorption across these sectors varies considerably. While technology absorption has been limited in all sectors, it has been more extensive in sectors where goods and services are being provided for local markets. Even in sectors such as petrochemical production where technology absorption has been limited, however, recipients benefit from technology transfers that help to build world-class export industries.

The chapter also examines broader issues relating to the larger (nonsectoral) implications of technology transfer. The analysis underscores the point that it is extremely difficult to predict these larger effects. In light of OTA's findings, it also addresses controversies concerning the broader national implications for technology transfers.

Some observers have suggested that technology transfers to developing nations necessarily challenge the status quo because they involve the introduction of foreign personnel, values, and equipment into traditional cultures. In their view, technology transfers are fundamentally destabilizing. Others see technology transfers as contributing to economic growth, which brings benefits to and improvements in the recipient society. A major theme in the discussion that follows is that the effects of technology transfer are conditional upon a number of factors, such as the pace of change, the distribution of benefits, and the wisdom of political leaders. Technology transfers, in conjunction with other social, political, and economic developments do have important effects, but it is not possible to identify the discrete contribution of all technology transfers on societywide change.

The civilian technology transfers examined by OTA have in most cases contributed to growth of Middle Eastern economies and the expansion of export revenues for Western nations. At the same time, OTA identifies problems associated with some technology transfers (e.g., potential nuclear weapons proliferation, anticipated export competition with Middle Eastern petrochemical manufacturers, and the symbolic use of technology transfer by various political groups) which are legitimate concerns for policymakers.

IMPACTS OF TECHNOLOGY TRANSFER IN THE SECTORS EXAMINED BY OTA

Chapters 5 through 9 examined the process of technology transfer in a number of civilian production facilities and service systems in the Middle East. The primary focus of that analysis was technology transfers occurring during the last decade of rapid economic growth. The sections that follow analyze and compare the effects to date. Technology transfers in these sectors are still underway, and in some cases, just beginning. Therefore, potential impacts are also mentioned where it seems appropriate. The major emphasis, however, is on analysis of impacts already apparent.

COMMERCIAL AIRCRAFT SUPPORT SYSTEMS

The primary effects of technology transfers in the commercial aircraft support systems sector have been economic. Sales of large commercial aircraft are significant in terms of the large dollar-volume of aircraft sales and in follow-on sales of auxiliary equipment, including testing and maintenance equipment, avionics packages, and spare parts. Requirements for technical services (including ground support) have made this sector an important revenue earner for the supplier firms, including not only the aircraft manufacturers and airport construction firms, but also airport management firms. For the recipient countries, these airlines are in many cases not great revenue earners, but they have added to the expansion of transport infrastructure.

The most significant problem, from the perspective of the suppliers, has been that competition among them has led to the expansion of government-supported export credits. These official credits represent a cost to the supplier governments and to taxpayers. In some cases, attractive financing has played an important role in competition for sales. The Organization for Economic Cooperation and Development nations have reached a special agreement covering export credits for aircraft sales. Nevertheless, continuing competition for sales of aircraft and support services among U.S. and West European firms indicates the need to strengthen agreements among suppliers about international trading rules.

The political or military effects of technology transfers in this sector are less clear-cut than the economic effects. Supplier governments have in some cases attempted to assist their exporting firms through high-level economic diplomacy, and the involvement of U.S.

firms in sales and servicing of aircraft in Saudi Arabia was preceded by discussions involving President Roosevelt. However, foreign policy controls affecting sales of U.S. aircraft have earned the United States a reputation as an unreliable supplier and have acted to reduce U.S. sales in the region. To many developing nations, commercial airlines stand as symbols of national prestige. In response to foreign policy controls, Middle Eastern countries have in some cases attempted to diversify suppliers. Because commercial aircraft exports have been subject to foreign policy controls, the political factors have strongly influenced trade in this sector.

Runways, fuel storage facilities, and radar capability contribute in a general sense to strategic defense capabilities. However, military equipment is much more specialized and complex than commercial airline support equipment, and civil aircraft maintenance experience is not directly applicable to military aircraft. Nevertheless, export controls have been used to restrict aircraft sales by those concerned about the spread of terrorist activities, who see these controls as necessary regardless of the consequences for commercial trade.

Among the sectors examined by OTA, technology absorption has been comparatively extensive in this sector. Indigenous personnel in the Middle East are increasingly performing the tasks needed to support and operate these airlines. For example, over one-half the pilots of Saudia (the Saudi Arabian airline) are currently nationals, in contrast to much lower representation of indigenous personnel in many other sectors (e.g., medical services). Indigenous personnel also hold key managerial positions in these airlines. However, particularly in Kuwait and Saudi Arabia, nonnationals, generally from other Middle Eastern countries, are performing maintenance and servicing functions. Therefore, despite comparatively high levels of technology absorption, some aircraft operations will probably not become fully staffed by nationals for many years.

There are a number of possible explanations for this pattern of fairly extensive technology absorption. First and foremost is the considerable length of experience. In a sense, commercial airline support systems represent a model for technology absorption in other sectors because many Middle Eastern countries have had commercial airlines for as long as a generation and the process of building indigenous capability has developed gradually over that comparatively long period. Secondly, the technologies involved are straightforward and well established, and procedures for training and operations are fairly standardized. Requirements of airline safety and maintenance have provided clear operational standards. Finally, Middle Eastern airlines serve local markets primarily and, while they have not all been profitable, they are viewed as important symbols of national prestige.

TELECOMMUNICATIONS SYSTEMS

The economic impacts of technology transfers in the telecommunications sector have also been particularly prominent. Telecommunications systems can be viewed as infrastructure in the sense that they provide the services needed for growth in other sectors. Of the Middle Eastern countries examined in OTA's research, Kuwait and Saudi Arabia have the most effective telecommunications systems. Kuwait's importance as a regional financial center depends, at least in part, on this system. In contrast to the aircraft support sector, local production of telecommunications equipment (including cables, crossbar switching, and television) has begun in some Middle Eastern nations and contributes to their ability to absorb the technology and to expand employment. The effects in job creation have been more notable in Egypt and Algeria, where more conventional technologies have been introduced, than in Kuwait, where state-of-the-art, capital-intensive technologies are preferred. Regional economic cooperation, through Arabsat, is particularly noticeable in this sector.

For the supplier firms, exports of telecommunications equipment and services have been important sources of export revenues. While large firms and consortia have been central as prime contractors, many small firms have also been involved as subcontractors and suppliers of equipment. The specific requirements of Middle Eastern countries have stimulated suppliers to modify and adapt equipment. As is the case in the aircraft support sector, official government export subsidies, including mixed credits, have been used extensively. As the disparity among the major suppliers in technological capabilities has narrowed, West European and Japanese suppliers have aggessively marketed their most advanced technologies in order to win contracts.

Political and social effects of telecommunications technology transfers include the linking of rural and urban areas and expansion of communications with other nations. In some cases, such as Egypt, the poor functioning of telephone systems has tarnished the reputation of supplier nations providing assistance in some projects. In Iran, the telecommunications system was used by revolutionaries to consolidate their power. Like civil aviation, telecommunication systems contribute to a country's strategic infrastructure, but the more sophisticated the military establishment, the more limited the overlap and substitutability of civilian and military communication systems. Certain applications of these technologies have important social effects. Radio and TV, for example, have been instrumental in the health education efforts of several Middle Eastern countries.

Technology absorption in telecommunications has been comparatively extensive, particularly in Egypt and Algeria, and in Iran before the revolution. Recipient governments have increasingly extended requirements for training by supplier firms, and supplier firms have established specialized technical training programs. However, in nations such as Egypt, where unemployment is high, the PTT (ARENTO, in this case) has expanded the number of employees beyond requirements demanded by the technologies, with a resulting decrease in efficiency of operations. Furthermore, due to the extensive requirements for lower skilled technicians in this sector, the Gulf States have faced problems attracting and keeping indigenous workers in these positions and in developing suitable curricula. Thus, the Gulf States have relied heavily on foreign Middle Eastern nationals to fill these positions.

Telecommunications, like aircraft support systems, function primarily to meet local requirements, and this provides a partial explanation for the development of recipient capability to operate and maintain the systems. Telecommunications systems serve captive markets. State-owned PTTs have introduced training and employment requirements in order to develop local capabilities. Local production, limited though it is, also certainly assists recipient firms in mastering standards and technology requirements. Regional cooperation in Arabsat also contributes to telecommunications planning capabilities in these countries.

MEDICAL SERVICES

To a greater extent than is true for the other sectors examined in OTA's study, the impacts of technology transfer in the medical services sector have been socioeconomic. During the last decade, the quality and longevity of the life of the average Middle Eastern citizen has improved because of better and more extensive medical services. These services have certainly contributed to the expansion of the productive work force. On the other hand, the urban middle and upper classes have benefited disproportionately from technology transfers in this sector, a trend that Middle Eastern planners are now attempting to rectify. Medical services employ large numbers of workers, and the personal contact required between medical personnel and patients accentuates the social and cultural effects on the society.

For suppliers, technology transfers in this sector have been priority concerns for development assistance. The U.S. Agency for International Development's programs involving preventive and rural health care have been generally well received in Egypt and have contributed to good political relations. Requirements for after-the-sale service and maintenance of medical equipment have stimulated private firms, particularly those in Europe, to provide specialized technical services. Personnel requirements at both professional and lower technical levels in the Gulf States have stimulated a large influx of foreign workers—from Western developed, Asian developing, and other Middle Eastern nations, such as Egypt and Jordan. Foreign medical workers there have been rewarded with high salaries, but they have also been obliged to accept restrictions on their behavior and political participation.

In medical services, technology absorption has been most varied, reflecting the wide range of channels for provision of services—ranging from small rural health clinics to large-scale, state-of-the-art curative hospitals. In the Gulf States, where large hospital complexes have been very recently established, technology absorption remains quite limited and reliance on foreign medical personnel will continue into the next century. In Saudi Arabia, for example, Saudi nationals make up only about 5 to 8 percent of the doctors and 10 to 15 percent of the nursing staff. Of all the countries included in OTA's study, Egypt has the greatest indigenous capability to operate and maintain medical facilities, but administration and infrastructure remain problem areas.

It is difficult to generalize about technology absorption in medical services across these countries, because they have developed strikingly different strategies for public health care. In the future, prospects for more extensive technology absorption appear good, because of growing experience and because of the pressing need for these services. Decisions made by government planners to promote curative or preventive health care will strongly determine the nature and extent of medical services technology transfers in the years ahead.

PETROCHEMICAL PRODUCTION

Like telecommunications and commercial aircraft support systems, the impacts of technology transfers in the petrochemical sector have been primarily economic. For recipient countries, the principal effect is in the potential that petrochemical production offers for providing substantial export revenues and for diversifying domestic economies now heavily centered on the oil sector. These effects will be particularly evident in Saudi Arabia, the nation with the most extensive petrochemical projects underway, but may also be significant for Algeria and possibly Kuwait. In addition, petrochemical production will allow these countries to use their natural resources better: in Saudi Arabia, for example, expansion of petrochemical production will provide an opportunity for better use of natural gas, which was previously often simply flared.

For the supplier countries, the economic effects have been twofold, albeit somewhat less positive. As illustrated by the experience of the Japanese firm Mitsui in Iran, the export of petrochemical plants and technology has been associated with investment risk. While investment risk is common to all the sectors, the large scale of the petrochemical projects may leave foreign firms more exposed. In addition, the growth of a Middle Eastern petrochemical industry will affect domestic production by supplier country firms, requiring some restructuring. This is particularly evident in Japan, where declines in anticipated market share and the perceived inability to compete against low-cost feedstock countries have already contributed to plant closure and industrial restructuring. Only in this sector have Middle Eastern firms extensively used equity investments in Western firms as a means to acquire technology.

The political and social effects of technology transfers in the petrochemical sector, on the other hand, have been comparatively limited. As a capital-intensive and export-oriented industry, employment effects are minimal, and the production of petrochemicals in the Middle East is expected to have only limited effects on local consumption patterns. Joint ventures such as the Saudi and Kuwaiti project in Bahrain promise prospects for greater regional cooperation in this sector. Disputes have arisen between supplier and recipient governments over petrochemical projects, and concerns have grown among West European producers over future import penetration by petrochemicals produced in the Middle East. These political disputes between recipient and supplier governments concerning petrochemical production in the Middle East have, however, been exceptions rather than the norm.

Compared to the other sectors discussed above, the extent of technology transfer in the petrochemical sector has been limited. Expatriate workers predominate in both production operations and management. As illustrated by efforts in Egypt, however, technology absorption may be extended through improvements in managerial capabilities and the establishment of manufacturing firms using petrochemical products to produce consumer and industrial goods.

COMMERCIAL NUCLEAR POWER

Of all the technology transfer sectors examined by OTA, commercial nuclear power is today the least developed in the Middle East. Nevertheless, there have been significant political, military, and economic effects. Even for oil-rich nations with considerable financial resources, planning for nuclear power development requires political commitment. Iran's ambitious peaceful nuclear power development program under the Shah, for example, became the object of criticism by revolutionary leaders who saw the program as grandiose Westernization, as well as by technocrats who questioned the scope of the program and the technical choices made. In Egypt as well, controversy over powerplant siting led to the revision of plans after opposition grew to the proposed Alexandria locale. Even more serious have been the dilemmas faced by nations intent on acquiring sensitive nuclear technologies. Iraq's program raised concerns among neighboring countries that ultimately led to a preemptive military strike by Israel.

Suppliers of nuclear technologies to these countries have been able to influence the nuclear programs of recipients. Nuclear cooperation agreements, like the U.S.-Egyptian accord, have provided incentives for recipient nations to accept full-scope safeguards and to provide assurances that intentions are peaceful. Suppliers have also influenced recipient programs through denial of certain types of technologies and through insistence that requests be modified to include technologies less susceptible to use in nuclear weapons programs. French proposals to use low-enriched uranium fuel for Iraq's research reactor are a case in point. Suppliers have been forced to expend considerable resources in attempting to build consensus among themselves on export policies, but the benefits in slowing weapons proliferation have been significant. Because OTA's analysis indicates that the likelihood of nuclear weapons proliferation in the Middle East will increase in the years ahead, the long-term risk of proliferation is certainly a liability that all supplier nations share.

Economic effects have also been noticeable. In the future, commercial nuclear power may provide low-cost electricity in countries such as Egypt, but to date, planning and preparation have been costly. Egypt will be able to develop nuclear power only with subsidized financing. Supplier firms involved in Iran's program have gained export revenues, but they also faced difficulties as construction was terminated by the new revolutionary government. In the future, supplier firms could be stimulated to develop small reactors to meet Middle Eastern requirements, but so far, firms have generally not considered such efforts to be cost effective. Some nations supplying nuclear technology have received oil from recipient countries, but there is little evidence that oil for technology deals have provided supplier countries with assured oil supplies in times of crisis. Indeed, France in 1983 was pressed to purchase Iraqi oil as the only conceivable means Iraq had to repay its debts. While in the future nuclear power may contribute to electricity generation in some Middle Eastern countries, the major economic effects to date have been felt by countries such as Iran and Egypt where purchases of and negotiations for nuclear power reactors have been carried to comparatively advanced stages.

Technology absorption has been quite limited in the nuclear sector, but a science and technology infrastructure is the foundation for future absorption of advanced technologies. Egypt has the largest nuclear research establishment, but the number of scientists and engineers working at the national nuclear research center (about 2,000) simply do not compare with the 18,000 in India's nuclear establishment, for example. Egypt has decided to import turnkey reactors. The major explanations for the limited technology absorption in this sector certainly lie in the complexity of the technology and in the reluctance of suppliers to provide sensitive facilities. On the other hand, in the years ahead, Egypt in particular may be able to improve gradually the capabilities of its scientists, engineers, and, most importantly, technicians, and may eventually operate and maintain power reactors independently. In the future, as Middle Eastern countries build their technical capabilities and as new suppliers perhaps more willing to sell sensitive technologies enter the market, military and political problems associated with nuclear weapons proliferation can be expected to grow.

COMPARISON OF SECTORAL IMPACTS

OTA's examination of the technology transfer process in all of these sectors indicates that technology absorption has been limited to the capability to operate and maintain technologies and equipment imported from abroad. In no case have recipients developed the capability to design or significantly adapt these technologies themselves. To be sure, adaptation of technologies has taken place, as exemplified by special features of the airport in Jeddah, Saudi Arabia (designed to accommodate the special requirements of the Muslim pilgrimage), the modification of telecommunications equipment for use in desert climates (heat- and dust-resistant modules), and the preparation of special training manuals for medical and technical personnel. In these cases, foreign consultants have generally carried out the modifications to meet requirements identified by recipient country nationals. This assessment of the extent of technology absorption, it should be stressed, applies only to the advanced civilian technology sectors examined in this study. In other sectors and in particular countries, the extent of technology absorption may be much greater. Egypt, for example, has had an Engineering and Industrial Design Center for a decade, and technology adaptation may have been carried out in certain sectors such as textile production and agriculture. (See fig. 1.)

In addition to the effects associated with technology absorption in the five sectors examined by OTA, there has also been considerable variation in associated economic, political, and social effects. While economic effects are apparent in all cases, social impacts were identified as particularly salient for medical services technology transfers, and political effects for nuclear technology transfers. In these sectors and during the time period examined by OTA, recipients have been more directly affected than suppliers. For policymakers in the Middle East, technology transfers in these sectors are central to national development plans. With the exception of technology transfers that raise issues of subsidies, export controls, and weapons nonproliferation, technology transfers have been more directly relevant to supplier firms than to supplier governments.

There are a number of possible explanations for the variations observed in technology absorption. Table 96 lists major areas of impact,

Table 90.—Major Areas of Impact of Technology Transfers in Sectors Examined by OTA

	Potential contribution to foreign exchange	Value of imported goods and technical services ($1982) to Middle East	Local production of equipment	Job creation in Middle East	Now serving local markets	Technology adaptation required	Level of indigenous capability developed	Regional cooperation in Middle East	Dual-use or military application
1. Commercial aircraft support systems	X	XX	X	XX	XXX		XXX	XXX	X
2. Telecommunications		XXX	XX	XXX	XXX	XX	XX	XXX	XX
3. Medical services		XX	X	XXX	XXX	X	XX	X	
4. Petrochemical production	XXX	XX		X	X		X	XX	
5. Nuclear power							X		XXX

KEY: XXX = large impact; XX = moderate impact; X = small impact.

SOURCE: Office of Technology Assessment.

including technology absorption as well as other types of economic, political, and other effects. Indigenous capabilities to use imported technologies have been most extensively developed in those sectors, commercial aircraft support systems and telecommunications systems, where there has been longer term experience with imported technologies and where the systems are currently serving local markets. In such cases, the industries and services are not forced to compete head-on with foreign firms, and recipient governments have the leeway to introduce local employment and training requirements.

In contrast, technology absorption in petrochemical production in the Middle East may be comparatively limited for some time, owing to the complexities of the technologies and to requirements ensuing from anticipated direct competition with petrochemical manufacturers abroad. In order to produce quality petrochemical products efficiently on world-class scales, Middle Eastern industries rely heavily on packaged technology imported from abroad and on the ongoing participation of expatriates. Packaged technology, in the form of turnkey nuclear powerplants, may also allow Middle Eastern nations to meet international operational and safety standards so important in that industry. Extensive technology absorption by recipients is only one indication of the effects of technology transfer; in sectors such as petrochemical production, recipients will reap foreign exchange revenues from transfers even though absorption is limited.

Because medical services technology transfers are so varied, involving both large-scale, capital-intensive hospital projects and small-scale, rural health clinics, it is particularly difficult to generalize about the extent of technology absorption in that sector. The prospects for development of indigenous capabilities in medical services appear good since these services are provided to meet local requirements, are comparatively labor-intensive (and therefore offer prospects for expanded technology absorption in countries like Egypt where labor is comparatively abundant), and have been given high priority by leaders in Middle Eastern countries.

Impacts of technology transfer vary widely across these sectors, but the most noticeable effects have been in expanding the productive capacities of countries in the Middle East. Improvements in medical and telecommunications services contribute indirectly but significantly, while expansion of petrochemical production directly contributes to manufacturing and export growth. By relying on technology importation in the form of packages that include long-term involvement of foreign workers, the firms importing technology can ensure proper functioning of facilities, even if indigenous capabilities are developed only gradually.

VARIATIONS IN NATIONAL EXPERIENCE

For both recipient and supplier countries, major issues have been associated with the importation of advanced technologies during the past decade. There has been considerable variation in the experiences of the supplier and recipient countries, and in the importance of political, economic, and social questions.

From the perspective of Middle Eastern leaders in these countries, the overall effects are undoubtedly viewed in a positive light. The fact that governments in all of these countries place high priority on technology transfer and are attempting to improve their capabilities to select and use foreign technologies indicates that their general assessment is favorable. Planners in the Middle East see technology transfer as essential for economic development, improvements in the technical expertise of the indigenous populations, greater social and economic welfare, an improved position in international markets, and as important in regional integration. They see technology transfer as generally raising national prestige, both regionally and internationally. For Middle Eastern countries it has brought expanded revenues from exports and remittances earned by workers working in the Gulf States.

On the other hand, however, Middle Eastern leaders do not disregard the potential negative impacts that technology transfer can bring in its wake: dependence on foreign suppliers of technology, an influx of foreign workers that may influence the social and political fabric of the recipient country, the creation of new social schisms among indigenous groups, disaffection among those groups that do not benefit from technology transfer, or the potential for embarrassment when technology transfers fail to achieve intended results. Saudi Arabia, Kuwait, and Iraq have found it necessary to import many foreign workers to carry out their development strategies, but at the same time these countries have attempted to limit the participation of expatriates in politics and society in an attempt to preserve national values and traditions, and in order to limit political disaffection. With the growth of Islamic fundamentalism, projects involving technology transfer have in some cases become targets of criticism by those who fear that Western influences are inimical to Islamic traditions. Although technology transfer, for the most part, is thus viewed in a positive light, the challenge for Middle Eastern planners is to minimize the associated real and potential negative impacts. Given these potential problems, it is not surprising that Middle Eastern policymakers increasingly emphasize technology transfers that contribute to the development of a local capability, rather than imports of high-technology equipment per se.

For many recipient nations, the political dimensions of technology trade have become increasingly important in the past decade. Hoping to exchange oil for technology and foreign expertise, some recipient countries have at times included promises of oil supplies in negotiations over technology imports carried on with foreign firms and countries. All of the recipient nations have come to emphasize the goal of diversifying suppliers, to greater or lesser degrees, for political and economic reasons, as discussed more fully below.

On the supplier side, the most noticeable dimension of technology trade in the sectors examined by OTA has been commercial, and the most direct effects of these technology transfers have been on firms rather than on governments. However, these commercial efforts are more significant for nations such as Japan, Italy, and France—whose worldwide trade is much more strongly directed to the Middle East—than for the United States. In a period of worldwide recession, the Middle East represented a fast-growing market for these supplier nations. Negative effects, in terms of investment losses due to revolution in Iran or repayment problems in Iraq, have been considerable for a few firms. For Western supplier governments as well as newly industrializing countries and many Soviet bloc countries, the

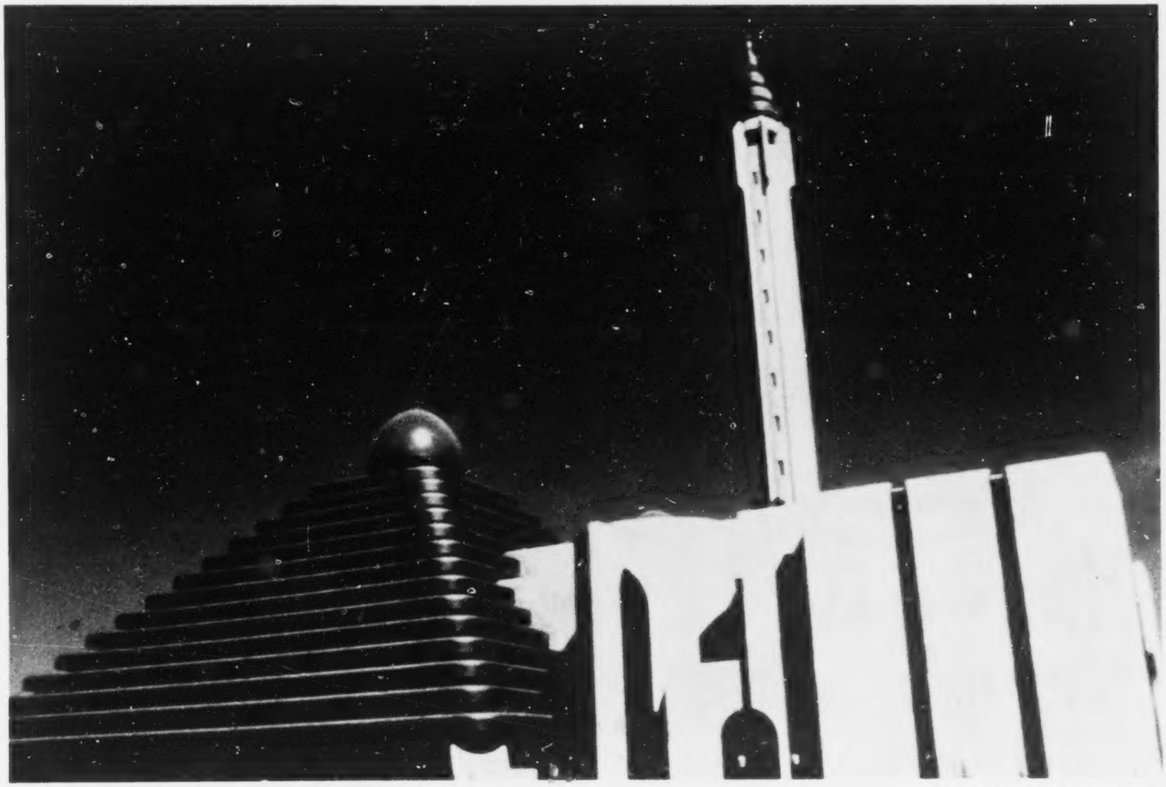

Photo credit: Embassy of Kuwait

The Nasser Sabah Al-Nasser Al-Sabah Mosque in Kuwait City

major economic effects have been growing export revenues. Suppliers have been stimulated to adapt technologies to requirements of Middle Eastern countries, and revenues from sales of equipment and technical services in the region have contributed to the ability of supplier firms to continue to innovate and develop technology. Much of this research and development takes place outside the region, but there are exceptions such as solar energy development in Saudi Arabia.

The newly industrializing countries such as South Korea and India have been primarily involved in exports of construction services, including lower skilled laborers and, in the latter case particularly, technical personnel. In general, these nations have not provided advanced technologies, but they have been involved in staffing and infrastructure building for large-scale projects. The major impacts on these supplier nations have been in the form of contracts and remittances earned by workers temporarily in the Gulf States. However, during the recent period of falling oil prices, many workers have been dismissed as the Gulf States cut back on new infrastructure projects.

For many West European nations and for Japan, technology trade with the Middle East has provided markets for industries faced with recession at home. In some cases, firms from supplier nations have, however, suffered investment losses associated with political and economic changes in host countries. With respect to the West European nations, technology trade has contributed at least in part to continuing but uneven efforts to establish multilateral policies toward the region. Competition among suppliers has stimulated some governments to intervene with export subsidies and supports for domestic firms. With the exception of the United Kingdom, most of these major Western suppliers of advanced technology continue to import large proportions of oil from the Middle East.

For the United States, the effects of technology trade have been similar to those affecting Western Europe and Japan. However, both exports to and imports from the region have been slightly less important in total U.S. trade than is the case for Japan, France, or Italy. Nevertheless, exports of technology to the Middle East have increased export revenues in a period when trade frictions between the United States and other nations have increased. As the postwar leader of the Western alliance, the United States has developed policies that emphasize political interests more than do those of most other Western suppliers. In part because of this emphasis, problems associated with the political dimensions of technology trade (including charges that advanced technology transfers may be destabilizing for the Islamic nations, or that they undermine relations with Israel) have been the subject of controversy. Technology trade and transfers have certainly helped to reinforce good political relations with countries such as Egypt and Saudi Arabia. On the other hand, foreign policy controls may well discourage or inhibit relations with other countries whose political relations with the United States are more ambiguous. Finally, the overwhelming preference of Islamic Middle Eastern countries for Western technology indicates that technology trade is an asset for the United States and other Western countries in countering Soviet influence.

Technology transfers have thus had important political effects. Through their policies governing nuclear transfers, suppliers have been able to influence the development of nuclear programs in these nations. While there has been some criticism of certain development projects, civilian technology transfers have reinforced good relations between the United States and the major recipient nations, such as Egypt and Saudi Arabia. On the other hand, because the United States alone has used foreign policy controls to limit exports of certain types for political purposes, these have undoubtedly reduced sales of certain types by U.S. firms and led some Middle Eastern governments to favor non-U.S. suppliers.

For the Soviet bloc nations, commercial technology trade with the Middle East has been quite limited in comparison to that of the Western nations. Nevertheless, exports to the Middle East make up a large share of these nations' exports to less developing countries worldwide. Egypt in particular changed policies and consciously reduced the involvement of Soviet advisors some years ago, an action that signified a setback for the Soviet Union. Political concerns remain paramount for the Soviet Union in its interactions with the region, but economic factors are increasingly important. For the East European nations, commercial exports, though limited to specialized niches, have been and remain at the center of their economic interactions with the region. The interest of Middle Eastern countries in diversifying suppliers may provide limited entrees for Soviet bloc exports in the years ahead.

BROADER IMPLICATIONS OF TECHNOLOGY TRANSFER

The previous discussion focused primarily on the past effects of technology trade and transfer. However, a decade is a relatively brief period and many projects are still under development. The long-term contribution of the technology transfers studied by OTA will probably not be clear for another 10 years, and in some cases even longer.

Nor have all effects on the lives of individuals and groups within these nations been identified. OTA's research was designed to focus primarily on the effects significant for the supplier and recipient governments and firms involved. In order to understand the effects on individuals and groups better, it would be necessary to ask their opinions and to observe the actual operation of the facilities. For example, such research might clarify whether male patients are troubled by the presence of female nurses in hospitals, whether foreign laborers resent restrictions placed on them by recipient governments, or whether certain ethnic or regional groups complain about unequal distribution of the benefits accruing from technology transfers.

Perhaps even more complex are questions concerning the indirect effects of these technology transfers. The technology transfers studied by OTA have generally occurred in a larger context of rapid change in the recipient countries. It is often impossible to identify the discrete effects of technology transfer, that is, to separate those effects from others associated more closely with social phenomena such as urbanization or expanded communication and political participation. Together with these other changes, the implications of technology transfer can be substantial.

Experts disagree about the causes of nationwide transformations, such as political revolutions and value change. Isolating the unique contribution of technology transfer to such developments is simply not possible. The decisions made by policymakers about what types of technologies to import, how rapidly to promote change, who should be involved, and who benefits are key to understanding the broader implications of technology transfer. If the term "technology transfer" is used vaguely to refer to all social changes, however, it loses its meaning. The content, determined by policymakers, is thus the key to evaluation of effects.

Policymakers nevertheless make decisions about technology transfer in the midst of uncertainty about its effects. While OTA's research cannot conclusively resolve the continuing debates about the broader effects of technology transfer, such disputes can be tentatively evaluated in light of this research. Controversies concerning the broader effects of technology transfer are evaluated in this section, with special reference to Iran. Iran is the one nation in this study that has recently experienced fundamental political changes. The anti-Western character of the revolutionary government has been viewed by some as a reaction against rapid Westernization under the Shah, one aspect of which was technology transfer.

TECHNOLOGY TRANSFER AND POLITICAL INSTABILITY

Some have argued that technology transfers are inherently "destabilizing," meaning that they embody foreign (usually Western) norms and values that come into conflict with traditions. In some cases, the argument goes, these conflicts erupt into opposition to the ruling regime, and sometimes lead to its downfall. Another approach to these issues is to see ruling elites as challenged to spread the benefits of technology transfer and to adapt it to local requirements and traditions in order to preserve their own political legitimacy. The first approach, it should be noted, equates technology transfer with all foreign influences and assumes an irreconcilable conflict between foreign and traditional values. The second places emphasis on the choices of leaders who determine the substance of technology transfer, and assumes that foreign and traditional values can be integrated or reconciled.

The second approach is useful for understanding the course of events in Iran. Under the Shah the problems of unequal distribution of benefits of technology transfer gradually became glaring, but these problems were the direct result of decisions taken by the ruling elite. The recipients of advanced technology in Iran were fiercely loyal to the Shah. The political elite were rewarded for their allegiance with technical assistance, feasibility studies, market surveys, and loans. In addition, technology transfers were selected to meet the growing consumer desires of the emerging middle class. A case in point were the modern private medical service centers established in Teheran as joint ventures between U.S. and Iranian firms, which were out of the reach of the average citizen. Since modern industry and the communications media served the Westernized upper-middle class, the resentment and frustration of other classes grew. The government promoted "growth poles" (called industrial estates), and the population of the cities swelled, accentuating the gap between the urban and rural areas. Technology transfers could have been promoted to achieve other purposes, such as enriching the countryside, but that was not done. The choices of political elites, rather than technology transfers per se, helped create the conditions that led to revolt.

Nor is it likely that the course of history would have been different if the United States had adopted an arms-length attitude. The Shah could have turned to any number of alternative suppliers in Western Europe and Japan to fulfill his technology requirements. If the Western nations had been unwilling, Soviet bloc nations would have been available as suppliers. The conclusion that must be drawn is that even if foresighted U.S. leaders had anticipated Iran's problems and instituted policies designed to reduce or modify technology flows, it is unlikely that such policies alone could have changed the political outcome.

Certainly large projects have, on occasion, become the objects of political criticism. In Iran, the revolutionary leadership criticized the ambitious nuclear program of the Shah as evidence of his craving for Western high technology. In other instances, large projects such as new airports in Saudi Arabia are viewed by many local citizens with pride, as symbols of national accomplishment. Because large projects involving technology transfer are highly visible in developing countries, they can be easily identified as objects of either criticism or pride. Choices made by leaders in recipient countries, and the ability of leaders to ensure that many groups in society benefit, shape political events rather than technology transfers per se.

THE TERMS OF TECHNOLOGY TRANSFER

Many observers have argued that technology transfers are fundamentally unfair. In their view, the supplier firms and governments have disproportionate power to dictate the terms of the transfers, with the result that the recipients pay too much, or receive technology that is out of date, or that suppliers are unwilling to provide the knowledge necessary for the recipients to absorb the technology fully. Underlying such criticisms are suspicions about the monopolistic character of multinational corporations, a theme that has reverberated in the debates over the proposed New International Economic Order. On the other hand, supplier firms point to their extensive training efforts, the investment risks associated with doing business in developing nations, and the inability of recipients to select and utilize technologies. The basic assumption of those who hold this view is that profit-maximizing firms are willing to sell technology, equipment, and services, but the recipient

Photo credit: Overseas Private Investment Corp.

Training programs carried out by the Xerox Corp. involving more than 200 local technicians are designed to improve communications and business support services in Egypt must know what to ask for and be willing to pay a fair price.

Many Iranian entrepreneurs objected to restrictive clauses and practices that prevented the full diffusion or utilization of imported technology. These complaints included claims that foreign partners would not provide adequate training and that unnecessary hurdles were placed in their way when they tried to use local components. Many Iranians saw themselves as increasingly capable of handling more complex tasks than they were assigned in production facilities. Some pointed to cases of influence-peddling by foreign firms.

On the other hand, expatriate supervisors and managers sometimes found recipients unable to handle certain tasks. In fact, there were cases of both successful and unsuccessful cooperation between U.S. and Iranian firms. In retrospect, the ability of both partners to understand and respect each other and the emphasis on training and technical assistance were distinguishing factors of those instances viewed positively by both sides. The role of Westinghouse in the military-owned Iran Electronics Industries Corp. has been cited by some as such a case. When both supplier and recipient firm partners prepared workers to understand and appreciate the values and norms of the other, the partnership was more often viewed as a success. In pre-revolutionary Iran, however, there were many cases of very costly projects which failed to achieve desired results. Anxious to introduce advanced technologies quickly and lacking the expertise necessary to make good choices or monitor progress, Iranian leaders sometimes accepted terms set by foreign firms which would not have been acceptable elsewhere. The foreign firms and the Iranian political elite in those cases benefited directly, while other groups in Iran grew more resentful.

All of these Middle Eastern countries have set restrictions on foreign direct investment, as outlined in chapter 11. Some countries, such as Iran under the Shah and Saudi Arabia today, encourage foreign investment more than others, but all maintain some restrictions. Such restrictions are designed to limit "dependence" on foreign capital. In Iran before the revolution, the percentage of foreign equity declined, but it is unclear that this came as a result of government policies. Throughout the region, the level of foreign investment remains quite limited. However, OTA's research does not indicate that low levels of equity participation by foreign firms necessarily ensure that reliance on expatriate expertise will be limited or that projects will achieve desired results. The extent of technology absorption, the economic benefits of the partnership, and the perspectives of both sides concerning "success" do not relate consistently to the level of foreign equity participation in the technology transfer sectors examined by OTA. In some cases, such as petrochemicals, continuing involvement by the foreign supplier is essential for the proper functioning of the production facilities. As discussed in chapter 11, Middle Eastern countries have developed different policies governing foreign investment; their assessments of potential gains and losses are in no sense uniform.

Regulations introduced by recipient (and to some extent supplier) governments attempt to ensure "fairness" in commercial technology transfers. Controversies continue, however, concerning the terms of technology transfers, indicating the serious concerns of developing nations. Recipients are improving their capabilities to select, bargain for, and utilize imported technologies. As this capability is improved, and as supplier firms have more experience in these markets, both sides may become more adept in striking terms which ensure that the projects are viewed as mutually beneficial over the long term. Competition among suppliers from many firms and nations for sales of advanced civilian technologies serves to limit the ability of any one actor to dictate terms of technology transfers.

"APPROPRIATE TECHNOLOGY" TRANSFER

The term "appropriate technology" means different things to different people. It has been used to refer to capital-saving technology, small-scale technology, and technologies needed for rural development. The underlying assumption of those who advocate the introduction of appropriate technologies has been that it is possible to identify technology transfers that are especially needed for the long-term well-being of developing countries. Some would also argue that particular types of technologies are "inappropriate" for developing countries. This last statement, in particular, has been disputed by leaders in many developing countries, who resent what they see as an attempt by those in developed countries to deny them state-of-the-art technologies required to compete directly with developed country firms.

OTA's approach has not been to assume that certain types of technologies are "appropriate," but rather to examine the process of technology transfer in a number of sectors and to observe results. The emphasis has been on assessing the extent of technology absorption and on understanding the perspectives of the supplier or recipient governments and firms concerning these technology transfers. Policymakers in the Middle East must make critical judgments about what kinds of technologies "fit" with their long-term economic development strategies. Such judgments require anticipating what the economy and society will be like some years hence and also require political leadership in building a consensus on how to get there.

Technology transfers such as those involving petrochemical production facilities that appear well-suited to Saudi Arabia would not be popular in other countries, where there is a larger indigenous labor force and smaller oil and gas reserves. As mentioned earlier, Kuwait has chosen capital-intensive, state-of-the-art telecommunications equipment, while Egypt has relied more on conventional telecommunications equipment that is more labor-intensive. Similarly, these nations have developed different health care strategies, with correspondingly different choices of technologies. Certain types of technology transfer (those introduced in systems operating to produce goods and services for local markets) were found to be particularly conducive to building recipient capabilities. Others such as telecommunications systems create linkages to other sectors, thereby causing "multiplier effects" in the economy. Of the technology transfer sectors examined by OTA, those in telecommunications and medical services had perhaps the most extensive effects on other domestic industries and on general living standards. In contrast, the critical effects of nuclear technology transfers have been political and military.

Photo credit: Aramco World Magazine

Merchants in Asir Province, Saudi Arabia

Photo credit: Aramco World Magazine

Modern supermarket in Saudi Arabia

What is appropriate in one country may be seen as inappropriate in another. Judgments about the appropriateness of the technologies depend on the fundamental goals and values of policymakers and citizens in these nations. Foreign suppliers are properly cautious when there is clear disagreement among various groups in recipient nations concerning certain types of technologies. Unfortunately, such disagreements often arise only after a project has been undertaken.

THE QUESTION OF "DEPENDENCE" ON FOREIGN WORKERS

Some argue that the presence of foreign workers in a developing nation is undesirable because it signifies ongoing dependence on foreigners and may lead to political and social unrest at home. Others argue that foreign workers make an important economic contribution and that their presence is generally beneficial to the host nation. OTA's research suggests that both types of impacts have been concerns in the Middle East. Expatriate workers in the Middle East must be present for technology transfer to occur, and the key questions are how long they stay and what they teach local workers in the process. Since no nation can be completely self-sufficient, the challenge is to utilize foreign workers effectively, based on a realistic understanding of both the problems that can arise and the potential contribution they can make. The question of foreign workers is part of a larger issue of dependence on foreign suppliers faced by developing nations.

Middle Eastern countries, particularly the labor-short Gulf States such as Saudi Arabia and Kuwait, have attempted to promote policies that utilize foreign workers while reducing potential political problems. Their concerns have been with potential political instability and with the prospect that foreign workers might attempt to influence host country policies, domestic and foreign. In Kuwait, for example, incidents of violence, both within and outside of the workplace, have been reported involving Palestinian workers, Indians, and others denied the rights and benefits afforded Kuwaiti citizens. On the other hand, developing nations appreciate the indispensable contribution of foreign manpower and expertise to economic growth. As discussed in chapter 11, these recipient nations have developed manpower policies to address both goals simultaneously, including the use of enclaves, to deal with the problems associated with employing foreign workers.

Foreign labor is also an important issue for supplier countries. In Egypt, for example, the supply of manpower to other Middle Eastern countries has been associated with both positive and negative effects: the migration of Egyptian skilled workers to other parts of the Arab world has brought with it significant revenue in the form of workers' remittances, but it has also proved to be the root cause of a "brain drain" in certain sectors. These issues are equally if not more salient for the labor suppliers outside the Middle East. The migration of Pakistani workers, for example, brought remittances amounting to approximately 50 percent of Pakistan's foreign exchange earnings in recent years, but it also caused social dislocations at home when men left their families behind. Because of the large number of Asian workers in the Middle East, the Asian countries that supply labor to the Middle East could be affected socially and economically by a sudden and sweeping dismissal of workers.

THE VULNERABILITY OF SUPPLIERS OF TECHNOLOGY TO RECIPIENT LEVERAGE

Some observers worry that suppliers of technology can become susceptible to undue leverage, economic and political, by the recipients. Underlying this perspective is the recognition that technology transfer involves long-term relationships between individuals and firms in both countries and the assumption that when supplier involvement is great, the result can be vulnerability to the whims of the recipient governments. In particular, some supporters of Israel fear that involvement by U.S. and Western firms in Islamic nations might result in those supplier nations succumbing to po-

Photo credit: Aramco World Magazine

Udhailiyah, located near the center of the giant Ghawar oil field, is the newest of Aramco's four permanent family communities

litical pressures counter to the interests of Israel. Others argue that technology transfer is primarily a commercial exchange and that the political leverage accruing to recipient governments is minimal or manageable. Some would take this argument further to suggest that the supplier actually gains considerable influence over the recipient in the process.

Debates over recipient leverage represent the obverse of questions concerning recipient dependence on suppliers. The major focus of concern has been with the issue of oil leverage, or the idea that Western governments in particular can be forced to take political stands contrary to their interests because of their dependence on Middle Eastern oil. Both Japan and a number of West European nations remain heavily dependent on oil imported from the Middle East and will remain so for years to come. Particularly during the period immediately following the oil crisis of 1973, West European and Japanese leaders moved to build bilateral alliances quickly with oil-producing nations, offering assistance in large development projects (including technology transfer) in conjunction with assurances of oil supplies. U.S. policymakers viewed these bilateral initiatives with concern because they seemed to some to diminish the ability of the Western nations to coordinate their policies through the International Energy Agency. In addition, the West Europeans and the Japanese took political positions independent of the United States and in some cases were more strongly supportive of Arab nations and the rights of Palestinians, increasing the concern about oil leverage. There is no question that oil is a major factor in the strategic and foreign policies of supplier nations, and technology transfers certainly occur within this context.

On the other hand, it does not appear that the nations that most aggressively attempted to build bilateral relations have been particularly successful in securing oil supplies in periods of crisis. While a multilateral embargo of oil by Arab nations would undoubtedly have considerable effect on consumer nations if it were prolonged, the threat of oil leverage by a single oil-producing nation is limited by the availability of alternative suppliers. In the near term, the recent leveling of demand for oil in the West has diminished the feasibility of oil leverage. In addition, Western nations have gradually put in place a number of policies—including emergency oil-sharing schemes, stockpiles, and energy conservation—which strengthen their capabilities to respond to sudden changes in the oil market. To be sure, oil is an important element in the relationship between France and Iraq, for example, and in the growing ties between Japan and Iran. OTA's research indicates that the joint venture partners in the Saudi Arabian petrochemical projects were attracted by guarantees of oil supplies in addition to favorable returns on investment. However, there is no evidence that the oil-producing nations have (through the use of oil leverage alone) successfully forced supplier governments to take positions which they themselves view as counter to their own interests. Indeed, some cases, such as the cancellation of British Foreign Minister Pym's trip to the Middle East in 1983 discussed in chapter 12, suggest that some suppliers are unwilling to subordinate their political principles to economic interests.

It is beyond the scope of this study to analyze the broader issues of Middle Eastern politics and diplomacy. However, OTA's research on the foreign policy context of supplier nation policies indicates that Western nations have established widely varying political relations with Middle Eastern countries. Chapter 12 analyzes the tendency of Western Europe and Japan to bring economics more to the fore in their policies than is the case in the United States. In some instances, these nations have developed policy perspectives that diverge from those of the United States. Some West European spokesmen, for example, question the appropriateness of an allied Middle Eastern policy and call instead for harmonization of policies. In their view, the alliance is strengthened when various Western nations develop relations with different Middle Eastern nations, rather than prohibiting trade with certain nations. Oil is certainly a consideration in these foreign policy perspectives of the technology-supplying nations, but it would be incorrect to conclude that Japanese and West European policies are determined solely by oil concerns.

Nor would it be correct to assume that suppliers gain no influence over recipients through technology transfers. While there is no evidence indicating that supplier nations have effectively forced recipients to modify their foreign policy positions simply by threatening to withhold or by offering to supply civilian technology, there have been cases where suppliers have successfully negotiated terms for transfers that maximize broader foreign policy interests. Suppliers have noticeably affected the type and extent of nuclear technology transfers. For example, by offering nuclear cooperation, the United States has persuaded Egypt to agree to very stringent safeguards on nuclear transfers. In contrast to nuclear export controls, however, there is little evidence that foreign policy controls have been implemented in the sectors examined by OTA so as to significantly reduce their access to advanced civilian technologies or change the political positions of the recipients.

This discussion does not resolve the issue of supplier vulnerability, but it does serve to caution against simply equating commercial relations with political positions. Evidence of both suppliers and recipients exerting influence is most apparent in the specific technology transfer contracts shaping the terms of transfer. Because the interests of supplier firms and their governments sometimes diverge, it is not necessarily the case that the commercial strategies of the firms will be strongly supported by governments. Technology transfer relationships require long-term interactions between suppliers and recipients, but sometimes the result is resentment and disagreement, while at other times mutual understanding leads to shared views and perspectives.

CONCLUSION

The impacts of technology transfers in the sectors examined by OTA have been widely varied across nations and technology sectors. It is difficult to identify and assess all the impacts of past technology transfers, and the task of anticipating future effects of proposed technology transfers is even more demanding. The implications for public policy are that it would be beyond the capacities of a supplier government to evaluate all proposed civilian technology transfers to ensure that all projects attain intended goals and that those are consistent with the national interest. Nevertheless, choices are currently made by many actors—supplier and recipient firms, in particular, and governments.

The long-term significance and promise of technology transfer is as a process that can stimulate continuing and self-sustaining economic growth in recipient nations, and one which can further the economic and technological progress of the suppliers as well. Whether these goals are achieved depends to a great extent on the wisdom of political leaders, particularly those in the recipient countries. The technology transfers examined by OTA have in most cases contributed importantly to the process of economic growth and technological development.

Another aspect of long-term significance is the influence of politics on technology transfer, seen in recipient attempts to diversify suppliers and in increased efforts by suppliers to use technology as a lever to reach political goals. Both supplier and recipient partners necessarily consider not only the risks of technology transfer, but also the promise of mutually beneficial exchange. The next chapters analyze efforts by both recipient and supplier governments to introduce policies which attempt to ensure that techology transfers achieve desired results.

CHAPTER 11

Recipient Country Policies

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CHAPTER 11

Recipient Country Policies

INTRODUCTION

Leaders of developing countries in the Islamic Middle East face a central challenge. With greatly diverse human, capital, and natural resources, they are making a determined effort to transform their economies rapidly, largely through the introduction of foreign technologies. In doing so, they are attempting to avoid excessive dependence on foreign suppliers of technology, to maintain their political legitimacy and to preserve Islamic traditions. Despite these common challenges, however, the policies of these countries reveal substantial variation in the ways they address these issues.

While many of them are establishing policies and programs affecting technology transfer, none of these countries in the Middle East has implemented an explicit and comprehensive technology transfer policy. Instead, technology transfer choices are normally made within the context of broader development strategies, and these have depended on the resources of each country, the vision of political leaders, and the social context. OTA's examination of policy approaches is designed to focus on the problems and promise of technology transfer for these recipient nations.

This chapter reviews policy choices made by Middle Eastern countries that affect technology transfer. Development goals and strategies are compared; the capabilities of central planning institutions to formulate and implement technology transfer are discussed; and specific regulatory, financing, and manpower issues are addressed. In each case, stress is laid on the central tradeoffs—between public and private leadership in economic development, between building an indigenous technological base and reliance on foreign assistance. Finally, technology transfer choices are set in the broader context of foreign policies.

The analysis highlights common themes in the approaches taken by these countries, perhaps the most central being attempts to liberalize economies to promote the growth of private sector firms, particularly in the manufacturing sector. Strongly associated with this trend have been efforts to regulate the involvement of foreign firms and organizations to enhance technology absorption, limit dependence, and promote political goals. While success has been uneven and approaches have varied, leaders in all of these countries have attempted to promote these dual goals of economic liberalization and regulation of foreign business.

DEVELOPMENT STRATEGIES

Development strategies have important implications for technology transfer choices. Development plans, of course, do not necessarily provide a good indication of actual performance. Crafted mainly as a guide to development, plan shortfalls have often been great and priorities often reshaped.[1] Plans do, however, reflect the aims of Middle East planners; they indicate where development priorities lie and how they change over time. For this reason, it is useful to examine briefly the development plans of each of the six countries under review as a basis for understanding policies relating to civilian technology transfer.

Despite the broad similarity in aims, there have been significant differences in the development strategies that each country has chosen. Some countries—Egypt, Algeria, and Iran—initially emphasized rapid development associated with heavy industrialization. Iran's "industrial dream," Algeria's aim for heavy industrialization, and Nasser's ambitious plans for Egypt in the 1960's were all examples of the desire to develop at a rate that would move each country into the 20th century within a matter of years. Saudi Arabia, Kuwait, and Iraq, in contrast, had somewhat more broadly based development strategies from the start, and the emphasis on heavy industry, if present at all, came at a later stage of development. In the 1960's, Egypt, Algeria, and Iraq emphasized a socialist approach to development; Kuwait, Saudi Arabia, and Iran stressed the importance of market forces, even though the government played a leadership role in all three. Government budgets also differ in size: Saudi Arabia's planned budget for 1984/85 is 60 percent higher than Iran's, and exceeds by a far greater margin those of Egypt, Algeria, Iraq, and Kuwait.

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[1] See, for example, Ministry of Planning, Saudi Arabia, *Education Statistics Manual*, summary, 1979.

During the past decade all of the countries under review have reevaluated their development strategies, and in some cases dramatically shifted priorities. This occurred earliest in Egypt, with the adoption of the "Open Door" policy in 1973 in an effort to liberalize the Egyptian economy. In all of the countries under review, in the late 1970's and 1980's, the scope of plans was scaled back and sectoral priorities were shifted in response to oil revenue declines.

ALGERIA

Algeria began its development program by stressing rapid industrialization in the context of a socialist model of development. Toward the end of the 1970's, however, priorities shifted toward emphasis on the long-neglected agricultural and infrastructural sectors, and the economy was liberalized. Socialism has not been abandoned, but has been made what Western observers termed more "pragmatic" to meet the demands of contemporary Algerian society.

In 1967, the Algerian Government launched its program of massive heavy industrialization, an orientation that continued well into the second and third plan periods. In the 1970-77 period, Algeria invested heavily in industry to the virtual exclusion or neglect of agriculture. During that period, the plan called for investment of 44 to 45 percent of the total budget in industry.[2] Especially after 1978, with the death of President Boumedienne, domestic critics within the government planning community began to criticize the strategy of heavy massive industrialization. Facing financial constraints, moreover, planners reassessed the role of the private sector and foreign involvement.

In the late 1970's, there was a marked shift in Algerian priorities toward the development of infrastructure, human resources, and agriculture. Efforts were made to open the economy more to private sector initiative and foreign participation. Table 91 shows the breakdown of expenditures for the latest 5-year plan, 1980-84. This plan calls for total investments of $104,527 million, almost half of which is to be allocated for programs studied and/or approved in previous plans. Gross domestic product (GDP) is projected to grow at 8.2 percent annually. The largest investment, totaling $40,339 million, will be in industry, but its share of total planned investment has declined to 38 percent. And while industrial development is still fundamental to Algeria's long-term policy, the focus has shifted from heavy to light industry. The country's critical housing sector received an allocation of $16,656 million, or about 17 percent of total planned investment, and education and training and social infrastructure together com-

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[2] By 1978, Algeria had achieved a status which was unique in the Middle East. The rate of investment in domestic industrial development (and related) projects was approximately 40 percent. But this high level of investment was at the expense of improved social, housing and consumer levels, and caused regional imbalances in Algeria's development. For planned and actual investments in agriculture and industry, 1970-77, see "Invertisements," *Synthese du Bilan Economique et Social de la Décennie*, prepared by the Ministry of Planning and Regional Development (Algiers: Republique Algerienne Démocratique et Populaire, May 1980), p. 5.

Table 91.—Algeria: Planned Government Investments 1980-84 (AD '000 million)

	Preprogramed schemes	New schemes	Total	Expenditure, 1980-84	Expenditure beyond 1984
Industry	79.5	132.2	211.7	154.5	57.2
Hydrocarbons	28.4	49.2	77.7	63.0	14.7
Agriculture	17.8	41.6	59.4	47.1	12.3
Forests	0.7	3.3	4.0	3.2	0.8
Agriculture	6.0	17.9	23.9	20.0	3.9
Water	10.9	19.1	30.0	23.0	7.0
Fisheries	0.2	1.3	1.5	0.9	0.6
Transport/economic infrastructure	19.9	36.2	56.1	37.9	18.2
Communications	6.8	12.5	19.3	12.5	6.8
Railways	1.8	7.1	8.9	5.0	3.9
Telecommunications	1.8	6.2	8.0	6.0	2.0
Storage and distribution	8.8	9.0	17.8	13.0	4.8
Industrial zones	0.7	1.4	2.1	1.4	0.7
Housing, education, and training	30.3	35.4	65.7	42.2	23.5
Social infrastructure	6.7	14.3	21.0	16.3	4.7
Health	3.6	6.2	9.8	7.0	2.8
Collective equipment	2.4	10.9	13.3	9.6	3.7
Production enterprises	3.4	21.6	25.0	20.0	5.0
Total[a]	196.9	363.6	560.5	400.6	159.9

Exchange rate: $1 = AD 3.8325 (1980).

[a] Totals may not add because of rounding.

SOURCE: Government of Algeria statistics and *Middle East Economic Digest*, Nov. 21, 1980, p. 20.

prised about 16 percent of total planned investment. The current plan thus represents a distinct shift away from the earlier preoccupation with heavy industrialization.

EGYPT

Egypt also had a socialist orientation and a similar emphasis on heavy industrial development during the 1960's, but this changed dramatically in 1973 with the economic liberalization initiated through Sadat's "Open Door" policy. During the 1960's, rapid industrialization along socialist lines, intended to reduce dependency on ex- or neo-colonial powers, was the dominant theme of Nasser's development strategy. Initially the Egyptian economy grew reasonably rapidly: industry and services increased their output and employment shares, while less emphasis was placed on the development of the traditional sector, agriculture. Concurrently, central planning became pervasive throughout the economy. By the late 1960's and early 1970's, however, the rate of economic growth in Egypt began to slow, and the rate of both investment and domestic savings sharply declined. Inefficiencies in the economy, costly external adventures such as the Yemen and 1967 wars, heavy defense expenditures, and a rapidly increasing population posed heavy burdens. In addition, the industrial strategy of Egypt, which had relied on import substitution or on building indigenous industries protected by high tariff walls, proved problematic. Instead of a decreased import bill, the rising import costs of raw materials and spare parts could not be offset by the export of locally produced products.

With the death of Nasser in 1970 and following the October War of 1973, the principles of a new economic strategy were put forth in President Sadat's "October Working Paper." In order to accelerate economic growth, the private sector was given a greater role and foreign investment was encouraged. The Open Door policy emphasized expansion of production capacity and the introduction of modern technologies (management systems as well as equipment) to realize that production. The Open Door policy has not achieved its stated goals, particularly the dynamic expansion of the private sector in industry and investment. But while fundamental economic reform remained elusive, Egypt's economy grew at a comparatively vigorous rate during the 1970's.[3]

The death of Sadat marked another change in development priorities, as a troubled world economy, the "oil glut," and growing imports severely eroded Egypt's foreign exchange balance. Although at the time Egypt was in the second year of the 1978-82 plan, a new 5-year plan was submitted in 1979. Table 92 shows projected targets in the present Egyptian plan for 1982/83-1986/87. The present plan calls for a total fixed investment of 34,790.6 million Egyptian pounds, with priorities directed to infrastructure (housing, utilities, electricity, transport, and communications) industry, and projects to increase exports. According to Egypt's General Authority for Investment and Free Zones, "the most important characteristic of the current plan is its emphasis on agriculture/agroindustry and infrastructure as targets for investment. This represents a shift from the reliance on basic industry as the key to future growth which characterized earlier plans, although development of manufacturing industry as well as petroleum and tourism is still given an important place."[4] The emphasis is on transforming more of Egypt's economy to an industrial base without minimizing the present and future roles of the nonindustrial sectors.

Table 92.—Egypt, Planned Investments, 1982-83 to 1986-87 (in million Egyptian pounds)[a]

Sector	Total investments
Agriculture and land reclamation	1,678.4
Irrigation and drainage	2,061.3
Industry and mining	8,616,9
Oil	1,336.7
Electricity	2,903.9
Contracting (building and construction)	941.7
Total commodity sectors	17,538.9
Transport, storage, and communications	5,779.1
Suez Canal	335.1
Commerce and trade	461.0
Finance and insurance	119.2
Tourism	452.5
Total production services	7,146.9
Housing	4,636.8
Public utilities	2,858.6
Education services	920.8
Health services	651.0
Other services	1,037.6
Total social services	10,104.8
Total fixed investment	34,790.6
Investment spending	695.5
Total investment	35,486.1

Some totals may not add because of rounding

[a] $1 = 0.8260 Egyptian pounds (July 1983).

SOURCES: Egyptian-British Chamber of Commerce; Stephen Timewell and Robert Bailey, "Weighing Up the Prospects for Success," Special Report, *Middle East Economic Digest*, July 1983, p. 4.

IRAN

Like Egypt and Algeria, Iran under the Shah embarked on a program of industrialization. But unlike those two countries, Iran's program was market-oriented from the start. In Iran's case the reevaluation that began in the late 1970's was accentuated by internal revolution.

The Shah had consolidated his royal power in the early 1960's and initiated a reform program called the White Revolution.[5] . By the early 1970's, the Shah declared that Iran would become one of the top military and industrial powers in the world by the turn of the century, and that by 1990 Iranians would enjoy the standard of living enjoyed by West Europeans. These dreams were called the Great Civilization, a sweeping 19-point program, which was reflected in Iran's Fifth Plan (1973-78). First—unlike Algeria and Egypt of the 1960's—the overall framework of the economy was to remain market-oriented, with the public sector providing the social overhead as well as a regulatory and supervisory function. At the same time—as in Algeria and Egypt—industrialization would be accelerated. For this, the government would carry on some functions of entrepreneurship and financing. Third, stress was laid on "basic needs" in health, education, and welfare and on enhancing "freedom and decisionmaking capabilities." Finally, priority was given to large, capital-intensive projects, to be initiated by the government if the private sector hesitated.

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[3] GDP grew 8.1 percent annually during the 1970-81 period, and the manufacturing sector at 8.7 percent. The World Bank, *World Development Report—1983* (New York: Oxford University Press, 1983), p. 150. For a detailed analysis of the complex relationship of public and private sectors in Egypt, see John Waterbury, *The Egypt of Nasser and Sadat* (Princeton, N.J.: Princeton University Press, 1983), especially ch. 8.

[4] The General Authority for Investment and Free Zones, *The Official Guide to Investment in Egypt* (Cairo, Egypt, 1982), p. 11.

[5] The White Revolution was a multifaceted modernization program begun in 1963. It consisted of six reforms, with one of the most important being land reform. These formed a basis for other reforms made subsequently.

As shown in table 93, this plan called for a total investment of $36.8 billion during the 5-year period, of which $22.2 billion was to come from the public sector and $13.5 billion from the private sector. Rapid growth in oil income, moreover, permitted an upward revision of the fifth 5-year plan, with greatly increased spending on economic development, social welfare, defense infrastructure, and public administration. The revised plan, submitted in 1974, provided for a near doubling of investment, to $69.59 billion. Investment priorities remained with industry, oil and gas, and housing, but the shares of investment in transport and communications slightly increased.

Performance, however, did not meet expectations. In the mid to late 1970's economic activity was slowed by work stoppages, supply shortages, overloaded infrastructure, inflation, and inefficiency. It became increasingly clear that "Iran's economic activity could not continue at the same frenzied pace; it had to decelerate gradually into a more sustainable tempo in order to ensure continued long-term growth."[6] A new cabinet, installed in 1977, attempted to restabilize the economy by promoting more "absorbable" growth, greater intersectoral coordination, and better overall socioeconomic balance. But these policies were nipped in the bud by the 1979 revolution.

Immediately after the revolution, some industrial projects were suspended or stopped, and development plans set back as leaders called for a shift to smaller scale industries. At present, the war with Iraq consumes a large part of the Iranian budget (according to Prime Minister Moussavi, approximately 30 percent of the budget is connected in some way with the war),[7] but oil revenues remain high, and by the early 1980's Iran's development efforts began again in earnest. For the fiscal year beginning March 21, 1984, a $48 billion budget was presented to the Majlis, or Iranian parliament. Of this, $5.5 billion was budgeted for education. Roads and transportation, health care and food and social security accounted for the next largest items in the budget. Approximately $2 billion was earmarked for industry, and industrial production is projected to rise rapidly.[8] Major pieces of legislation have been enacted, such as land reform and foreign trade nationalization. Projects begun under the Shah have been rein-

Table 93.—Iran: Total Fixed Investment 1973-78 (billion U.S. dollars)

	Original	Revised	Share of revised budget (%)	Increase on original budget (%)
Industry and mines	8.18	12.53	18.0	53
Agriculture/natural resources	2.67	4.58	6.6	72
Transport and communications	2.79	7.29	10.5	161
Housing	5.96	13.78	19.7	130
Oil and gas	6.83	11.72	16.8	72
Others	10.41	10.77	28.7	90
Total	36.34	69.59	100.0	

NOTE: Conversion based on $1 = Rs 67.50

SOURCES: Compiled from Bank Markazi Annual Report, 1974-76, p. 34; from Robert Graham, *The Illusion of Power* (New York: St. Martin's Press, 1978), p. 31.

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[6] Jahangir Amuzegar, "Growth Without Pain: The New Iranian Development Strategy," *Middle East Problem Paper*, No. 18 (Washington, D.C.: The Middle East Institute, 1978), p. 1.

[7] See "Prime Minister Presents Draft Budget to Majlis," Tehran Domestic Service in Persian, Nov. 29, 1983, translated in FBIS, Daily Report, South Asia, Nov. 30, 1983, p. 13.

[8] See Vahe Petrossian, "Khomeini's Iran Radiates Self-Confidence," *Middle East Economic Digest*, Mar. 18, 1983, p. 20; see also Vahe Petrossian, "The Iranian Economy—Back to Essentials," *Middle East Economic Digest*, Apr. 6, 1984, p. 18.

stated. Despite earlier statements that Iran did not need the presence of outside experts, the Iranian Government is slowly bringing back foreign experts from Western Europe, Asia, and the Soviet bloc.

IRAQ

Like Algeria and Egypt in the 1960's, Iraq began its economic development program with a socialist orientation; but unlike these two countries, the goal was not rapid industrialization. Instead, Iraq placed greater emphasis in the 1960's on agriculture and light industry. And beginning in 1972, major efforts were made to create a triadic economy based on oil, resource-based industries, and agriculture. Initially, this was conceived as a three-step process: In 1972, oil production and export facilities such as terminals and pipelines were expanded and modernized. Next, heavy investments were made in export-targeted, resource-based industries in 1974-75. The development of downstream facilities related to hydrocarbons and petrochemicals was a centerpiece of this effort. The third step in the development plan involved consolidation and elimination of manpower and infrastructural problems. Significant emphasis was placed on agricultural development for the long term. Educational, medical, and housing sectors, which contribute to productivity of labor, were also central concerns.

As elsewhere in the Middle East, a decline in real oil prices in the late 1970's caused a reevaluation of development strategies. But for Iraq in particular, the necessity to trim back development plans was exacerbated by the outbreak of war with Iran. Initially, Iraq adhered to a policy that emphasized continuing both the war effort and economic development policies full steam. Today, however, with no end to the war in sight and tremendous declines in oil revenues, Iraq has been forced to abandon this policy. In 1983 the decline in aid from the Gulf States, coupled with the shutdown of Gulf oil terminals and the Syrian pipeline, led to severe austerity measures, with only the most strategic development projects continuing to receive public funding.[9] In the latest 5-year plan (1981-85), expenditures were projected to reach $75 billion, with emphasis on services, electricity, transport, and construction.

SAUDI ARABIA

Saudi Arabia and Kuwait (discussed later) are both market-oriented, oil rich, and relatively poor in indigenous labor. They are attempting, through the purchase of advanced technology with their tremendous oil wealth, to diversify their economies away from oil. But whereas Saudi Arabia has emphasized industrial development, Kuwait as a city-state has shied away from this—outside of the petroleum sector.

From the early 1970's Saudi Arabia's development strategy focused on balanced economic development in a free market economy. Saudi Arabia's relatively balanced and modest first 5-year plan (1970-75) reflected these aims. Spending, including defense, was only $8.8 billion (1970 rate of exchange) and was primarily aimed at basic infrastructure, such as ports, roads, and schools. When the oil price increased in the middle of the first plan, there was no chaotic rush to development; instead, the first plan was extended by 2 years, to 1975, generally along the same guidelines. The second Saudi 5-year plan (1975-80) was aimed at industrial development and human services, particularly higher education and telecommunications, with health services (in contrast to those of Kuwait) receiving only 2 percent of the budget. Total spending rose to a supposed $142 billion, or more than 16 times that of the first 5-year plan. But as a result of substantial underspending and earnings much higher than anticipated, reserves grew to more than $100 billion by 1980. During the decade of the 1970's, then, initial emphasis on infrastructure gave way gradually to stress on industrial plans and manpower development.

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[9] Human losses from the war with Iran—estimated at over 50,000 as of December 1983—have drained Iraq of much-needed manpower resources. See Roger Matthews, "Iraq: The Real and Unreal War," *Financial Times*, Dec. 9, 1983.

With the decline in oil revenues in the early 1980's, Saudi development plans were cut back, although shifts in sectoral priorities were not as great. Table 94 shows total government expenditure by sector for the second and third development plans. The third 5-year plan reflects a continuing commitment to finish basic industrial plants. But instead of the past emphasis on high growth in all sectors, relatively free import of foreign labor, and infrastructure development, the plan now stresses selective growth, consolidation of the foreign labor force, and economic and human resource development. Infrastructure, for example, received half the total development budget in the second plan, but only a planned 35.5 percent of the budgeted funds in the third plan. Instead, the third plan places heavy emphasis on training Saudis and replacing foreigners, reflecting the concern about the failure to reach the manpower training goals of the second development plan.

Beginning in 1982-83, Saudi Arabia began to slow (and even cut in absolute terms) the level of public expenditure. In 1983-84, expenditures were reportedly about $68 billion, and revenues were about $64 billion, producing a deficit estimated at $3 billion to $14 billion. Saudi Arabia made a comparatively smooth adjustment to lower income levels.[10]

Like other Middle Eastern countries (e.g., Egypt in its free zones), Saudi Arabia stresses regional development in its plans. One feature which stands out in this regard in scope and scale are two industrial development projects, Yanbu and Jubail, which the Saudi development plan accords special consideration (see ch. 5). In this respect, the objectives of the third plan include the construction of massive whole new ports and cities for basic petroleum and energy-related industries, as well as the building of needed industrial and community infrastructure and the training of Saudis to man the industrial plants.

Today, the Saudis have begun planning the fourth 5-year plan period, scheduled to begin in the spring of 1985. With much of the essential infrastructure already in place, efforts will continue to diversify the oil-centered economy. The challenge of building the manufacturing sector in a period of slower growth in oil revenues will undoubtedly be a central issue in the years ahead.

KUWAIT

Of the Middle Eastern countries under review, only Kuwait decided early not to build large nonoil industries, recognizing that it was too small to support more than a few industries, and mostly those associated with petroleum. Instead, Kuwait has plans to emerge as

Table 94.—Saudi Arabia: Planned Government Expenditures, 1975-80 and 1980-85 (in SR billion, current prices)[a]

Function of expenditures	Total planned expenditures[b] 3rd plan (1980-85)	2nd plan[c] percent (1975-80)	3rd plan percent (1980-85)
Economic resources development	261.8	25.1	37.3
Human resources development	129.6	15.9	18.5
Social development	61.2	9.4	8.7
Physical infrastructure	249.1	49.6	35.5
Subtotal: development	701.7	100.0	100.0
Administration[d]	31.4	6.7	4.5
Emergency reserves, subsidies	49.6	15.9	7.1
Total civilian expenditure	782.7	122.6	111.6

[a] $1 U.S. = 3.33 SR (1980 year average).
[b] The total excludes: 1) transfer payments, 2) noncivilian sectors, and 3) foreign aid.
[c] Based on actual and estimated values converted into 1980 prices.
[d] Administration includes ministries and agencies with primarily administrative functions, and judicial and religious agencies.

SOURCE: Kingdom of Saudi Arabia, Ministry of Planning, *Third Development Plan, 1400-1405 A.H. 1980-85 A.D.*, p. 88.

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[10] Edmund O'Sullivan, "Saudi Arabia: Learning to Live on Less," *Middle East Economic Digest*, Mar. 9, 1984, p. 20.

a financial and service center for the region. In the early to mid-1970's, therefore, government investments were concentrated mainly in public works and services. Despite the establishment of the General Authority of the Shuaiba Industrial Area, industrialization has remained a lower priority, and the approach has been cautious and gradual.

As in other Middle Eastern countries, the financial pressures ensuing from lower oil revenues caused a basic change in the pace of Kuwaiti development which began in the late 1970's. In 1983, project expenditures were substantially reduced, and several large projects long underway were temporarily stopped or canceled.[11] But in light of continued high investment income for Kuwait, these changes represented more of a scaling back of existing plans rather than a reorientation of priorities.

Government investment in industry is mainly confined to oil-related enterprises, where the goal is to upgrade and expand the refining sector and perhaps to build a petrochemicals complex. Outside of the oil sector, Kuwaiti plans have stressed expenditures in urban development, ports, transportation and roads, power generation and transmission, and social programs (table 95). The government, although providing some incentives, leaves industrial development to Kuwaiti entrepreneurs.

To summarize, all of the Middle Eastern countries under review have had generally similar development goals: sustained economic development, infrastructure building, development of manpower resources, and improvement in basic living standards. All of them have reevaluated development strategies during the last decade, with the result that emphasis has in most cases shifted away from exclusive stress on heavy industrialization and toward economic diversification. Nevertheless, specific development goals vary widely (ranging from Kuwait's aim of becoming a financial center to Algeria's stress on agriculture and light industrial development) as do approaches to these goals. These different development strategies have important implications for technology transfer.

Table 95.—Kuwait Government Draft Budget: Expenditures by Ministries (Kuwait Dinars, in millions)[a]

Expenditure by ministries	1981-82	1982-83	Percent change
Defense, Interior, and Justice	312.8	338.0	8.0
Education	221.5	246.0	11.0
Health	171.7	191.5	11.5
Information	40.0	39.2	−2.0
Social and Labor Affairs	43.2	48.9	13.2
Electricity and Water	538.7	619.0	14.9
Public Works	260.2	231.5	−11.0
Communications	75.8	73.8	−2.6
Finance (General Adm. and General Accounts)	1,127.8	1,012.4	−10.4
Oil	3.3	90.5	374.2
Planning	21.8	27.9	28.0
Housing and Government Property	1.6	1.2	−25.0
Commerce and Industry	44.5	44.3	−0.5
Endowments and Islamic Affairs	9.5	9.6	1.0
Foreign Affairs	23.9	20.2	−15.9
Amiri Court and Others	33.4	38.7	15.8
Supplementary allocation	66.6	124.3	86.6
Total expenditures	3,007.7	3,168.0	5.3

[a] 1 KD = $3.59 U.S. (1981 average).

NOTE: Does not include investment income.

SOURCE: National Bank of Kuwait, vol. One, No. 2, October 1982.

IMPLICATIONS FOR TECHNOLOGY TRANSFER

Technology transfer from abroad has been a major requirement of all the development strategies pursued by Middle Eastern countries. Initially, however, little explicit attention was given to technology transfer in official policies. Iran was probably the most vigorous in its early pursuit of Western technology transfer; other countries such as Algeria and Egypt initially relied more on the Soviet Union. In the past decade, however, all of these countries have come to place high priority on the acquisition of Western technology. In addition, as development goals were reevaluated, issues concerning the scale and type of technology transfer, the relationship to foreign suppliers, and the role of science and technology policies were more directly addressed.

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[11] A case in point was the indefinite postponement of a billion dollar petrochemical complex. See "Coping in the Gulf," *The Washington Report*, May 30, 1983, pp. 4-5.

One key issue has been the decision about whether to import capital- or labor-intensive, industrial or nonindustrial, technologies. With a limited manpower base, Saudi planners have chosen capital-intensive technology in order to build world-class industries. In prerevolutionary Iran, where the population was many times greater, leaders likewise attempted to acquire state-of-the-art, capital-intensive technology while talking about employment-generating, foreign exchange-saving, or linkage-creating technologies.

In those countries poorer in capital but richer in labor, this has become a central issue. In Egypt it is being debated and official policy remains unclear. Some planners argue that capital-intensive technologies are needed in some sectors to complement continuing labor-intensive production in others. Other planners, however, oppose this approach, which they see as weakening local manufacturers while making Egypt even more dependent on foreign suppliers. In Algeria, where development plans shifted away from heavy industrialization, labor-intensive technology importation has become more prominent. While capital-intensive technology transfers remain central to the development strategies of all those countries, in some cases there has been growing interest in labor-intensive technologies.

A second major issue has revolved around relationships with foreign suppliers of technology. Desiring technology developed abroad, but wishing to limit dependence on foreign technology, these countries have adopted widely differing approaches.

Kuwait's approach to technology transfer has been to purchase directly from foreign suppliers. In some cases, this has involved the equity purchase of foreign firms. To Kuwaiti planners, investment in foreign companies and technology transfer go hand in hand. Probably the best known example is Kuwait Petroleum Corp.'s (KPC) purchase of Santa Fe International Corp. in 1981. The purchase of Santa Fe for $2.5 billion has given KPC substantial upstream capability in exploration and oilfield services. C. F. Braun & Co., Santa Fe's subsidiary, provides KPC with in-house process engineering capacity, already being utilized in a major domestic refinery upgrading scheme. Kuwait's 25 percent investment in the West German firm Hoechst reportedly led to an ammonia supply agreement with that company.[12] This investment-oriented approach has been questioned at home by those concerned with costs and by observers in the West who worry about foreign acquisition of domestic firms. While investment in a foreign firm does not guarantee technology transfer, it may open up markets for products and facilitate long-term interactions.

In Saudi Arabia, on the other hand, planners have emphasized technology transfer through joint ventures. "Foreign capital investment in the field of manufacturing," the Saudi Consulting House states, "particularly in the form of a joint venture for which considerable incentives are granted, is highly encouraged in the Kingdom. The basic objective is to effect a transfer of technology and management know-how."[13]

Saudi leaders welcome continued foreign involvement because they believe it ensures technology transfer. The Saudi "strategy" requires the joint venture foreign partner to provide advanced technology, sometimes to market the product, and often to provide training for Saudi nationals. Egypt also encourages joint ventures, but more for financial than manpower reasons. In Saudi Arabia, the shortage of technical manpower is a main stimulus.

In years past, Algeria, Iraq, and prerevolutionary Iran, more wary of foreign involvement, have all stressed acquisition of technology in turnkey plants, with technical assistance designed to lead more quickly to independent operation. Iraqi planners set a strategy whereby foreign expertise may be utilized in Iraq for a period of time to train indigenous cadres, but only on a short-term basis.

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[12] Shakib Otaqui, "Kuwait's Economy Defies Crash and Crisis," *Middle East Economic Digest*, Aug. 26, 1983, p. 19.

[13] *Guide to Industrial Investment* (Riyadh: Saudi Consulting House, 1981), p. 102.

Algeria has also traditionally emphasized technology transfer through turnkey operations, for many of the same reasons. But unlike Iraq, Algerian planners began in the early 1970's to promote joint ventures with foreign partners, albeit on a more limited basis than did Saudi Arabia. The Chadli government currently supports joint ventures with foreign firms on a close to equity basis rather than large-scale turnkey contracts because such joint ventures will, it hopes, encourage more technology transfer through in-house training of Algerian personnel and the greater long-term commitment of the foreign partner to the joint enterprise.

As technology transfer has increased, many Middle Eastern countries have attempted to establish a more coherent plan for linking science and technology development. Especially during the past few years, many of the countries under review have begun national planning exercises to define policies better in this area. Policymakers concerned about the ad hoc nature of their approach to technology transfer and limited technology absorption believe that policies must be greatly improved in this area.

For some years now, Egyptian leaders have been working to build a science and technology policy for their country. (App. 11A includes a summary of major recommendations from studies on science and technology in Egypt.) An Egyptian 5-year plan for science and technology, completed in December 1982, marks the first time that such a plan has been attempted, and is an impressive achievement. The plan is very broad in scope. One problem has been linking the general discussions of science and technology to the immediate needs of the end-users of technology. For example, a draft code on technology regulation is under development, but sectoral priorities have not been set. This exercise has undoubtedly increased coordination and awareness among government agencies, however.

In many of the other countries under review, organizations have been established to formulate national science and technology policies. In Saudi Arabia, for example, an independent agency—the Saudi Arabian National Center for Science and Technology, or SANCST—was created in 1977 to formulate and coordinate a national science policy for the Kingdom, to direct scientific research to areas of national interest, and to oversee the acquisition of foreign technology. Two objectives have been central to Saudi discussions of a science and technology policy: the transformation of society's material conditions through the selection, transfer, and management of advanced technology while simultaneously preserving cultural values; and the development of the Kingdom's natural and human resources by reducing the economy's dependence on foreign manpower and on depletable hydrocarbon resources.

All of the countries have viewed scientific research as important to building an indigenous technical base. Science is, however, generally rather removed from the immediate needs of industrial end-users of imported technology in developing countries. It is therefore striking that in all of these countries, technology transfer has become an issue in its own right. As a matter of national debate among key leaders, the emphasis has often been on coordinating the various government agencies involved in an attempt to formulate a more consistent policy. In practice, however, routine decisions about which technologies to import, from whom, and under what conditions tend to be driven by development plans as implemented by the functional agencies.

PLANNING AND ADMINISTRATIVE INSTITUTIONS

Institutions that plan and carry out development strategies are critical for technology transfer because they incorporate technical, commercial, managerial, financial, and research expertise required to diagnose problems effectively and to select and fully absorb technologies. The purpose of this section is to review institutional mechanisms developed in Middle Eastern nations. The central themes are changes in institutional structure, and the relationship of public and private sectors in formulating and implementing technology transfer policies.

As in other developing countries, Middle Eastern leaders face two central institutional issues important for technology transfer: creating an effective network of institutions to formulate and implement technology transfer policies and defining the respective roles of the public and private sectors. The countries under review range from those, such as Egypt, where the number of organizations involved in technology transfer is very large and the decisionmaking apparatus very diffuse, to countries such as prerevolutionary Iran, where decisionmaking was highly centralized under one man. Similarly, variation is evident along the second dimension as well: Saudi Arabia and Kuwait encourage the private sector to play a central role in technology transfer, while socialist countries such as Algeria and Iraq have in years past more carefully circumscribed the private sector role.

Despite these differences, the countries under review have much in common. First, these countries are not unique in their efforts to create efficient institutions and in their struggle with issues such as centralization versus decentralization of decisionmaking. Second, it should be stressed from the outset that the public and private sectors are actually closely interrelated in the countries under review; and while it may appear on the surface that the two are at odds, they are very much mutually dependent. In all of the countries under review, moreover, the state plays the pivotal role in technology transfer, while the role of the private sector has been limited.

It is particularly striking that in recent years, all of the countries under review have increasingly pursued policies aimed at more administrative decentralization and a greater degree of economic liberalization in promotion of the private sector. This has been true even in those countries, such as Algeria and Iraq, that have pursued a socialist and centrally directed course of development.

In attempting to develop effective institutions, policymakers in the Middle East must deal with concerns of various political and social groups. Powerful groups—such as those that have vested interests in the status quo—often oppose reform aimed to improve efficiency. Institutional questions therefore should be viewed not only as matters of efficiency, but also as political and social issues.

EGYPT

In Egypt, a large number of government organizations—ministries, authorities, agencies, and departments—participate in the planning, project implementation, and operation of public companies, and the number of government employees is comparatively high. By the mid-1970's, more than 1 million employees were concentrated in government administration. During the latter part of the 1970's, the number continued to grow reflecting a tradition of guaranteeing a job to all university graduates. By the late 1970's the Egyptian Government employed about one-third of the total work force and paid nearly two-thirds of the national wage bill.[14]

Within this wide range of people and institutions, the Ministry of Industry and Mineral Wealth—which is responsible for the formulation of industrial policies that influence technology transfer and their implementation—is a key institution. Its main operating arm, the General Organization for Industrialization (GOFI), formulates the long-term industrial strategy and makes routine decisions that directly affect technology transfer to Egypt. The main functions of GOFI that relate to technology transfer include the formulation of industrial development plans to guide the public and local private sectors; cooperation with foreign and domestic organizations and firms transferring technology; collection of data on industrial production and assistance in the dissemination of information on technological innovation; identification of investment opportunities; conduct of preinvestment and feasibility studies for industrial projects; participation in conjunction with concerned companies in concluding contracts for machinery and equipment deliveries; review of applications submitted by foreign investors; and examination of applications submitted to the Ministry of Industry for licenses to establish or expand Egyptian industrial private enterprises. GOFI has a broad mandate and exercises considerable authority in dealing with specific cases of technology transfer.

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[14] Waterbury, op. cit., p. 244.

In addition to GOFI, a number of other institutions are involved in different aspects of technology transfer. Under Law 43 of 1974—the main law governing foreign investment in Egypt (see below)—the General Authority for Foreign Investment and Free Zones (GAFI) was established as its primary implementing agency. While the Board of GAFI must approve all private investment proposals, however, the technical evaluation of proposed investments is made by the appropriate line ministry and is ultimately reviewed by GOFI.

The Academy of Scientific Research and Technology (the ASRT) functions as a coordinator of science and technology policies, as mentioned above. The ASRT, in turn, is comprised of a number of specialized research councils, such as the National Council of Education, Scientific Research, and Technology (NCESRT), the National Council of Production and Economic Affairs (NCPEA), and principal committees, that work to build policy consensus in various areas. The ASRT and its committees, however, are not the actual implementors of technology transfer.

As mentioned earlier, the private sector has also been promoted in Egypt since the early 1970's. Today, however, the role of the nonagricultural private sector in the Egyptian economy is still limited, and the public sector predominates. The large Egyptian Government bureaucracy has gained a reputation for inefficiency and lack of coordination among the large number of public enterprises, government agencies and organizations, and private companies. Indeed the present Egyptian 5-year plan expresses concern over problems in the public sector, including "poor administration, managerial and technical capabilities, inadequate allocations for replacement and renewal of assets, increasing indebtedness and liquidity problems, increasing losses due to the government's attempts to control price movements . . ."[15] Technology transfer is constrained by long delays in approving foreign investment projects and lags in delivery of goods.[16]

Economic and bureaucratic reform remain common themes among Egyptian planners. But while Egyptian planners stress the need to streamline the public sector and provide the private sector greater scope, most of the investment envisaged in the present 5-year plan is allocated to the public sector, and decentralization of decisionmaking has progressed slowly. Egypt's Minister for Investment Affairs and International Cooperation, Wagih Shindy, has since assuming his post in 1982 announced a series of "antibureaucracy measures" directed at encouraging foreign investment.

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[15] Quoted in Charles Richards, " 'Made in Egypt'—A President's Dream," *Middle East Economic Digest*, Special Report, July 1983, p. 20. Although the public sector accounts for about 90 percent of current industrial investment, for example, it provides less than three-fourths of industrial output.

[16] For a discussion of this, see David Ignatius, "Egyptian Bureaucracy Galls Both the Public and Foreign Investors," *The Wall Street Journal*, Mar. 24, 1983, p. 1. For a discussion of some of the private and public sector debates, see Henry Bruton, "Private Enterprise and Social Welfare," *Investment Review*, July 1980, p. 3.

These include shortening the review period for foreign investment proposals and consolidating the authority to eliminate the confusing overlap of responsibility among various ministries. While it is too soon to know whether the effect of these measures will be to improve the Egyptian investment climate, these steps indicate strong commitment among some Egyptian leaders to reform.

ALGERIA

Although there are many who play a role in technology transfer to Algeria, decisionmaking in Algeria as it relates to technology transfer is comparatively centralized, with a limited role reserved for the private sector. The main actors are the ministries and the 60 to 70 state companies, or the societés nationales, under their jurisdiction. The Ministry of Planning and National Development, the most significant organization in setting overall priorities for technology transfer, determines the goals of the 5-year plan and any subsequent modifications. Other ministries are responsible for decisions concerning their particular sectors. The ministries currently responsible for setting priorities and planning for the government in the five sectors studied by OTA, for example, are the Ministries of Planning and Regional Development, of Energy and Petrochemical Industries, of Health, of Posts and Telecommunications, and of Transportation and Fisheries (for civil aviation), and the President's Commission for the Development of New Forms of Energy (for nuclear power). State companies such as the oil and gas company Sonatrach are the end-users of the technology in most cases.

Algeria's private sector has traditionally played only a small role in technology transfer. During the first 6 years after President Boumedienne came to power (1965-71), most of the industrial and service sectors and all major foreign and domestic enterprises were nationalized and organized into national, state-owned corporations. It is estimated that by 1972, Algerian state-owned companies controlled 90 percent of the industrial sector and employed 70 percent of the industrial personnel; the public sector was clearly dominant in most areas of economic development and almost all areas of technology transfer.

Nonetheless, despite this heavy centralization of the public sector, a small but significant private sector has continued to exist in Algeria, with the public sector clearly dominant and the private sector concentrated in light industry and the services. The Algerian Government encouraged this by offering strong material incentives to private investors, for example, to invest in projects deemed vital by the government.[17] In the mid-1970's, under the new Chadli government, the private sector was further expanded. With a significantly better record for productivity than the state or public sector, the private sector was officially encouraged to participate in the development process and was allowed greater leeway in its participation.

In theory, the authority to make decisions about technology transfer is clearly specified. The appropriate minister (e.g., of Energy and Petrochemical Industries) decides on a given project after a state company (e.g., Sonatrach) makes the proposal. The sector of Sonatrach that has initiated the project then negotiates the project, being responsible for the publication of the tender, the selection of the most appropriate offer made by international contractors, and the negotiation and implementation of the contract terms. However, the minister may exercise veto power. Once the contract is approved by the minister, the state company responsible for initiating the project purchases equipment and begins implementation.

In practice, however, a high degree of centralization in decisionmaking requires a large number of intermediate steps that often result in considerable delays.[18] Technology transfer at every step of the process in Algeria, from visits of the chief executive officers of major U.S. firms to Algiers to the signing and execution of contracts, has been fraught with delays and a degree of bureaucratic arbitrariness that seriously impedes smooth and harmonious cooperation.[19] According to foreign businessmen, approximately 60 signatures may be required by Sonatrach to authorize the purchase of spare parts for a gas liquefaction plant. In general, delays from 1 to 2 years from contract letting to final contract approval are apparently not uncommon.

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[17] As outlined in the Investment code of 1967, these included a 10-year total or partial exemption from real estate tax; reductions on some import duties; tax exemptions; and other incentives to attract particularly large private sector investments in industry.

To combat these shortcomings, the Chadli government has instituted a number of measures to decentralize decisionmaking in many public sector institutions and to further legitimize the role of the private sector. It has also introduced a number of measures to cut down on corruption[20] and to streamline the operations of existing institutions—such as the establishment of the Audit Council. The recent decentralization of Sonatrach into 13 sectors, for example, and the reorganization of other state companies (e.g., Sonacome, the State mechanical engineering company) suggest a greater concern with efficiency in Algeria's public sector. In addition, a resolution adopted in late December 1981 by the Central Committee of the Front de Liberation Nationale (FLN) Party assigned a greater economic role to Algeria's private sector. The Planning and Regional Development Ministry, for example, has set up a new department to promote industrial opportunities for private businessmen in Algeria.[21] But while the private sector is being strengthened, the Algerian Government has not departed from preserving the leading role for the state in the "strategic" sectors and most aspects of technology transfer. The role of the private sector thus remains circumscribed, and the public sector is still clearly dominant in large-scale industry, finance and imports, and much of agriculture.

IRAQ

In Iraq, technology transfer decisions in particular, and planning and supervision of economic growth generally, are centralized in the presidency, the Revolutionary Command Council (RCC), the Báath Party, and the ministries of government. The RCC and the party set economic targets and priorities, with input mainly from the Central Bank, the Planning Ministry, the Finance Ministry, and the line ministries.[22] While major project goals are formulated at all levels, proposals compete for attention at the RCC and planning levels and the RCC serves as final arbiter.

The inner workings of the RCC and Báath are not well understood outside Iraq. Keeping in mind that directives from administrative or party superiors may be interposed at any point in the process, however, the basic elements of decisionmaking can be briefly described. Details of the proposed project are sketched out by planning board officials, often in consultation with foreign experts and advisors. Preferences for certain kinds of equipment have been developed by the line ministries, based on political considerations, past performance, reputation, and other factors such as terms of credit. Bids are invited largely through resident commercial attachés. Three criteria have been important in the selection of a project to be implemented by a foreign concern in Iraq: the project's importance for the country's welfare, its speed of implementation, and its size. A final decision to proceed is made by "the Committee," composed of the Oil-Affairs, Follow-up, and Agreement Implementation Committees.

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[18] "In an increasingly regulated, increasingly supervised and increasingly inefficient world, the Algerian bureaucracy maintains its standing as one of the most difficult with which to deal . . . " John Nellis, "Maladministration: Causes or Result of Underdevelopment? The Algerian Example," *Canadian Journal of African Studies*, vol. 13, No. 3, 1980, pp. 410.

[19] Interviews in 1983 with two French officials directly involved in negotiating contracts with Algerians for infrastructural projects (e.g., dams, railroads and rapid transit systems) suggested that the many intermediate steps—negotiations on contract terms, the written acceptance of the contract by both parties, the issuance of a letter of award by the Algerian party, the formal signing of the contract, ministerial approval of the contract by the relevant ministry, financial approval of the contract by the Ministry of Finance, issuance of an import license (authorisation generale)—are frought with delays and red tape.

[20] For a discussion of this and other measures to monitor or cut down on corruption in public sector organizations, see R. Kh, "The In-House Opposition Which Bendjedid Inherited From Boumedienne and Augmented is a Preventive Measure That Did Not Forestall Opposition Outside the Government," *Al Nahar Al-'Arabi Wa Al-Duwali*, No. 190, November 1982, pp. 22-28; translated in FBIS, "Status of Local Opposition Analyzed," Joint Publications Research Service, Near East/South Asia, Jan. 1, 1983, pp. 1-3.

[21] In addition, beginning in January 1983, the 31 wilayates, or provincial governments in Algeria have been given the authority to receive contracts from private Algerian firms to initiate public projects with the provincial government or with municipal governments, although this may not exceed about 30 million A.D. (approximately $6.6 million). See "Algeria Relaxes Private Sector Barriers," *Middle East Economic Digest*, May 13, 1983, p. 40.

[22] The National Assembly, recently resurrected, has not attained the importance it held in planning before the rise of the Báath Pary, particularly in its highly centralized current form. Also significant here could be the Regional Energy Commission, but this has yet to become apparent.

Once a project has been selected, it is carried out under the direct supervision of the committee or, if the committee so decides, of a ministry or other official or semiofficial authority. The committee is the legal authority to which the contractor must appeal for making "necessary decisions relating to the project" and for granting "any exemptions." A technical committee is also formed to coordinate and study the mode of implementing the project. The technical committee may award special exemptions and privileges, such as tax exemptions and lifting restrictions on work permits. Thus the contracting officials have considerable discretion in defining the terms of the contract. The Ministry of Industry, especially its Standing Committee for Growth and Development and its Organization of Industrial Investment, regulates technology transfer.

In practice, several observers have cited a relatively high degree of centralization and coordination in Iraqi economic planning. A significant factor accounting for this coordination in policy, these observers feel, has been the personal loyalty due the President and the similarity of background of a number of leading participants; several, for example, have come from the village of Tikrit, are relatives of the President, or have served with the President in other capacities.

Nonetheless, the system is not monolithic in Iraq. The technocrats, who have been increasingly Western-educated, are afforded opportunities to make proposals that may be at odds with those of the main political leaders. In Iraq, the input of technocrats is considered important, but their views may be overruled at any point by a relatively small group of political superiors. As Iraq's President Saddam Hussein has stated:

> You cannot deal with the major economic and technical questions without consulting the technical experts. But do not leave the job of economic leadership to them. Give them no opportunity to assume the role of leader. Instead, they must always work under the direction and leadership of the revolution, which has unlimited capacity and expert technical knowledge. It knows the revolution, understands the methods by which to alter society in general and which direction the change should take, and uses every economic movement to serve itself and its aims.[23]

Although the private sector has traditionally played a very small role in Iraq, in recent years the government has attempted to liberalize the economy and invite private firms to play a larger role. In Iraq's first 5-year plan, for example, 50 million Iraqi dinars were set aside for industrial private investment; the present plan (1981-85) includes 380 million dinars for the purpose.[24] The Iraqi Government has also been expanding the industrial cooperative bank, offering low-interest loans to private industrial investors. And Law No. 115 enacted in 1982 offered other incentives to private investors. The permitted ceiling on the size of private investments was raised and tax exemptions were offered to private industrial firms; profits which are reinvested into research and development and the purchase of patent rights and know-how, for example, are now tax exempt. Iraqi decisionmaking is thus comparatively centralized, but differences in the viewpoints of the political and technocratic leaders nevertheless surface, and the private sector has been promoted. Political leaders, however, make the final decisions. The war with Iran has led to many strains on the system, leading to delayed negotiations with and payments to foreign contractors.

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[23] See Amir Iskander, *Saddam Hussein: The Fighter, The Thinker, and The Man* (Paris: Hachette Realités, 1980), p. 233.

[24] See "Government Encourages Private Sector," translation of *The Baghdad Observer* (Clela Khoshaba), Sept. 24, 1983, p. 4, in JPRS Near East/South Asia, Dec. 14, 1983, p. 20. In response to these and other measures, the amount of private investment in Iraq has clearly grown. According to official Iraqi estimates, private investment in industry grew from ID 24.4 million 1972—81 period to ID 150 million in 1982.

IRAN

The administrative framework for technology transfer was quite centralized in prerevolutionary Iran. It rested largely in the hands of the monarchy.[25] The cabinet, consisting of some 20 to 30 ministers and other technocrats handpicked by the Shah himself, was responsible for translating the Shah's broad objectives into actual plans. But unlike many other constitutional monarchs, the Shah played a personal and direct role in the decisionmaking process.

While the various ministries were in charge of implementing projects, the Plan and Budget Office (PBO) drew up the national development plans. Under the nominal jurisdiction of the Prime Minister, the director of PBO enjoyed a great deal of autonomy and direct access to the Shah. PBO drafted the 5-year development plan as well as the government's current expenditures budget. A second layer of more functionally specific institutions provided funds or addressed specific aspects of project implementation. The two most important funding institutions to facilitate the goals of industrialization were the Industrial Credit Bank (ICB)—affiliated with PBO and mandated to provide loans, equity financing, and technical assistance, primarily to the public sector companies—and the Industrial and Mining Development Bank (IMDBI), a quasi-governmental bank whose functions included loan, equity, and technical assistance to the private sector.

In addition to financial institutions, the Ministry of War also had access to financial resources and sometimes directly imported or set up its own industries. The Military Industries Organization (MIO), an umbrella organization established by the Ministry of War, set up firms such as the Iran Electronics Industries (IEI). IEI, for example, was established with the goal of making the military, and eventually the entire economy, self-sufficient in a wide range of electronic products. It set up subsidiaries and signed a variety of technical assistance contracts with major U.S. electronics firms such as Westinghouse and Control Data Corp., and by the eve of the revolution in Iran at the end of 1978, had assembled a professional cadre of about 2,000 electronics engineers and other specialists.

In the civilian sector, a similar nucleus of industrial innovations and entrepreneurship was the Industrial Development and Renovation Organization (IDRO), created by Parliament in 1967. IDRO was an autonomous government corporation mandated to: 1) establish and operate certain heavy industries; 2) renovate and rejuvenate the deteriorating government factories through technical, managerial, and financial assistance; and 3) contribute to the development of technical and managerial skills in Iran. IDRO created a management and technical training school (Industrial Management Institute), a consulting group (Technology), several dozen manufacturing firms such as the Arak and Tabriz machine tools factories, and the Metallurgical Research Center Co. But while the government of Iran was the prime instigator of development and technology transfer, as IDRO exemplified, the private sector grew to be a significant part of the economy and, in particular, an important source of investment. Iran saw the rise of industrial private entrepreneurs, oriented toward export industries, who were increasingly involved in technology transfer.

Postrevolutionary Iran initially appeared to be a sharp departure from the Shah's Iran.

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[25] See Robert Graham, *Iran: The Illusion of Power* (New York: St. Martins Press, 1978), chs. 8 and 12.

Some institutions of government were dismantled, new Islamic institutions were created, and state control of the economy was expanded. Recently, however, Iranian Government and religious leaders have reestablished some institutions from pre-1979 and appear to be trying to provide a bigger role for the private sector. In contrast to earlier statements, Iranian leaders have recently encouraged a greater role for the private sector in the Iranian economy.[26] Thus, in Iran today as before, the relationship of the government to the private sector firm remains an unsettled issue. The dominant role of government planning, however, remains the central theme.

SAUDI ARABIA

Government decisionmaking in Saudi Arabia remains primarily in the hands of the royal family, but many other people are also involved in economic decisionmaking.[27] The key participants in the formulation and administration of technology transfer policies are the ministries, a number of specialized agencies that have been created during the past 12 years (including industrial, consulting, and research organizations), and funding organizations such as the Real Estate Development Fund and the Public Investment Fund.

The key ministries responsible for industrial development are the Ministry of Industry and Electricity and the Ministry of Planning. The latter is responsible for preparing the Kingdom's 5-year development plans. The former is responsible for processing foreign investment applications and for regulating domestic industrial development and industrial cities.

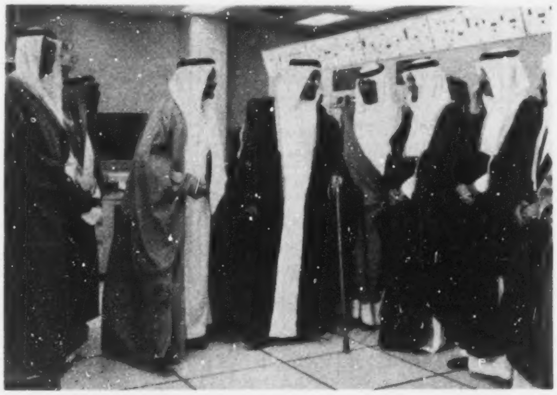

Photo credit: Aramco World Magazine

King Khalid holds impromptu court at inauguration of Ju'aymah Fractionation Plant and Marine Export Terminal, 1980

Of the specialized agencies, four are most important in the development of hydrocarbon-based industries, and hence for technology transfer associated with them: the Saudi Basic Industries Corp. (SABIC), the Royal Commission for Jubail and Yanbu, The General Petroleum and Minerals Organization (Petromin), and ARAMCO. A government holding company under the chairmanship of the Minister of Industry, SABIC's purpose is to carry out an industrialization program based on Saudi Arabia's gas and oil resources. With an authorized capital of over 10 billion Saudi riyals (SR) in the late 1970's, SABIC has set up a number of petrochemical and metal projects in cooperation with foreign investors. SABIC also set up the Royal Commission specifically to guide the development of Jubail and Yanbu, two industrial cities on the east and west coasts, respectively. Petromin, the Kingdom's oldest hydrocarbon development organization, and ARAMCO (now fully owned by the Saudi Government) have for years been important actors in technology transfer.

The Saudi Consulting House (SCH), an independent organization, provides consulting services to government agencies and private investors. Formed as a spinoff from the Ministry of Commerce in the mid-1970's, it provides professional and technical services in three areas: engineering and technical services, economic industrial and management services, and legal services. Also a spinoff of the Ministry of Commerce, but still under its jurisdiction, the Saudi Arabian Standards Organization (SASO) may be increasingly important to technology transfer to Saudi Arabia because its purpose is to develop national standards for all commodities. SASO has participated in international and regional organizations since its founding in 1972 and has been assisted by the U.S. National Bureau of Standards under the auspices of the U.S.-Saudi Joint Commission.

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[26] For a discussion of the role of the private sector in post-revolutionary Iran, see "Kind Words for the Private Sector," *Middle East Economic Digest*, Nov. 25, 1983, p. 11. The article quotes Ayatollah Montazeri as stating on Nov. 9: "Past experience has shown that government without reliance on the private sector and without adequate protection for it will be unable to meet popular needs . . . If the government wishes to establish an efficient system of distribution without the need for engaging more and more salaried personnel, it should work in cooperation with the private sector . . . " Majlis Speaker Hashemi Rafsanjani is quoted as advocating a greater role for the private sector as well, albeit within limits: "The private sector should be present, and free enterprise is one of our primary principles."

[27] For a detailed description of Saudi Arabia's political system, including the Council of Ministers, see Fouad Al-Farsy, *Saudi Arabia: A Case Study in Development* (London: Kegan Paul, 1982), ch. 4.

In addition to these institutions, R&D is promoted by other institutions, some mentioned earlier, such as the Saudi National Center for Science and Technology (SANCST). The University of Petroleum and Minerals is also a major resource for industries; it houses the Saudi Arabian Institute of Scientific Research, which has links with research institutes in the United States, Europe, and Japan and is undertaking projects in environmental science.

The Public Investment Fund (PIF) is the key funding institution for basic industries and technology transfer. Chaired by the Minister of Finance, and capitalized at a total of 16.6 billion SR (about $4.88 billion) in 1978, PIF has been involved in major petrochemical joint ventures under the third plan and is also empowered to buy and sell shares in newly established companies. Other funding organizations include the Saudi Industrial Development Fund (SIDF), the Real Estate Development Fund (formed in 1975), and the Saudi Arabian Agricultural Bank, which was formed in 1962 but did not become very active until the late 1970's.

Unlike Algeria, Iraq, and 1960's Egypt, promotion of the private sector has always been at the core of Saudi development strategies. Emphasis on the private sector has increased in recent years. In Saudi Arabia, incentives such as loans on favorable terms have been provided to private investors by SIDF. In addition, promotion of joint ventures between Saudi Arabia's growing private sector firms and foreign partners was to be carried out through the planned National Industrialization Co.[28] Other incentives include tariff exemption on imported equipment and materials; tax incentives; assistance with studies and operations; provision of low-cost utilities and fuels; and the provision of infrastructure, including industrial estates. Thus, the general approach is for the state to take a lead in the planning and execution of major industrial projects at an early stage and to promote private enterprise in nonoil manufacturing.

KUWAIT

In Kuwait, the development of financial institutions has been the main effort, in line with Kuwait's efforts to become a financial center in the Middle East. Central to this effort are Kuwait's three large investment banks, or the "three Ks," as they are commonly called: the Kuwait Foreign Trading Contracting and Investment Co. (KFTCIC); the Kuwait Investment Co. (KIC); and the Kuwait International Investment Co. (KIIC). KFTCIC, formed in 1965, is the largest of the three and is 80 percent government owned. Unlike the other two, it is actively involved in the Eurocredit market and in direct investment abroad. KIIC, on the other hand, established in 1973, is smaller, almost exclusively privately owned, and involved primarily in Kuwait's domestic economy, primarily in tourism, shipping, and the hotel industry. In the middle, both in terms of size and in combination of public and private sector ownership, is the KIC, formed in 1962 with 50 percent ownership by the government and 50 percent by private interests. The

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[28] The SIDF provides interest-free loans of up to 50 percent of capital to industrial projects with a service charge of 2 to 3 percent, and managerial advisory services. See also, Michael Petrie-Ritchie, "Saudi Arabia's NIC Seeks Foreign Partners," *Middle East Economic Digest*, Apr. 6, 1984, p. 45. The same article reports that the number of privately owned industries grew from 600 in 1975 to 1,600 in 1984 (with a total of almost $8 billion invested).

KIC's main purpose is to develop investment opportunities for Kuwaiti surplus capital, emphasizing joint ventures with Kuwaiti equity participation.

In addition to the three Ks, Kuwait's six commercial banks, three specialized banks (real estate, industrial development, and savings and credit) and other financial institutions such as the Kuwait Finance House (KFH, Kuwait's only Islamic bank) play a key role in Kuwaiti development and technology transfer. Most important among them is the Central Bank of Kuwait (CBK) which is the second largest commercial bank in Kuwait. In addition to acting as banker and financial advisor to the government, the CBK also finances Kuwaiti development projects. Although its international operations are extensive, the thrust of the bank's activities is domestic. Major domestic projects in which CBK participates are the industrial relocation of Sabhan, the supply and installation of switchgear at Shuaiba North power station, road construction and other services, and performance guaranteees for refineries and drilling platforms. To handle overall responsibility for the general management and supervision of Kuwait's investments (over $75 billion in 1983), the National Investment Authority was approved by the National Assembly in June 1982. The National Investment Authority will gradually take over management of all Kuwait's reserves, which amounted reportedly to $74 billion in mid-1983.

Outside the financial sector, several other Kuwaiti institutions are also important for technology transfer. In addition to the ministries that are involved in purchasing and transferring technology, the state-owned Kuwait Petroleum Co. (KPC) is the main institution acquiring technology in the hydrocarbon sector. KPC has been involved in long-term investment development of Kuwait's oil industry. During the past few years, KPC's domestic operations have been extensive: oil and gas exploration, drilling, and production fall under the purview of its Kuwait Oil Co. (KOC); production, marketing, and sales of petrochemical products fall under the Petrochemical Industries Co. (PIC); crude oil and gas refining and marketing of refined products fall under the Kuwait National Petroleum Co. (KNPC); and overseas exploration falls under the Kuwait Overseas Petroleum Exploration Co. (KOPEC). Chapter 5 discusses Kuwait's downstream investments in Europe, where refined products will be marketed.

Photo credit: Embassy of Kuwait

National Assembly of Kuwait

The Kuwait Institute for Scientific Research (KISR) is the key institution for R&D. With a wide mandate, KISR supports assessments of industries and technological development in Kuwait and joint scientific projects with foreign organizations. KISR's National Scientific and Technical Information Center (NSTIC) is considered a major source of information on science and technology. KISR currently is involved in research ventures with international institutions such as the Battelle Institute in West Germany, the Institute of Petroleum in France, the IFAS in Sweden, Nevada's Desert Institute and Chicago's Gas Institute in the United States, and with several American universities.

In Kuwait there have been attempts to control the growth of the civil service to make government more efficient and less dominant in the economy. As a city-state, Kuwait's goal of becoming a regional financial center sets it in contrast to the other nations under review.

TECHNOLOGY TRANSFER: KEY POLICY ISSUES

REGULATION

Middle Eastern countries have established laws and regulations to encourage technology transfer and to ensure that a capability to operate and maintain technology is gained, that unfavorable impacts are minimized, and that dependence on foreign assistance is limited. The specific legislation and regulations of each country, therefore, include both incentives, in response to the demand for technology and know-how for rapid development, and regulations, in response to the desire for extending indigenous capability and control. On the one hand, all of the countries under review have offered incentives for technology transfer such as tax holidays, guarantees against nationalization, and security of investments and import/export regulations. On the other hand, regulations have been introduced to channel foreign investment into certain economic sectors or geographical areas of the country, to ensure a level of local ownership, and to require training of indigenous personnel. The use of agents—required in some Middle Eastern countries, and prohibited in others—provide both incentives and disincentives for technology transfer. And licensing—although limited—has also been accompanied by regulations that require provision of technical services in each of the countries under review.

Despite these overarching similarities, there is substantial variation among the countries. The legislation and regulations of Egypt, Saudi Arabia, Kuwait, and prerevolutionary Iran, for example, have tended to be more supportive of technology transfer than those of Iraq and Algeria. In the latter two countries, regulations have generally been more stringent, but both countries appear to be loosening controls. Similarly, the prominence of Islamic law varies throughout the region, although its direct impact on technology transfer has generally been limited.

Egypt

A complex combination of incentives and regulations is perhaps best illustrated in Egypt. Although not specifically designed as a legal instrument for regulating the transfer of technology, Law 43 of 1974—subsequently revised in Law 32 of 1977—sets the legal context in which technology transfer occurs. Devised as part of Sadat's Open Door policy, its purpose is to attract foreign investment and technology transfer—mainly from the Western industrial nations—to develop the country and to channel that investment into areas of the private sector.

With regard to incentives, investors who form a company under Law 43 are given tax breaks, financial support, and assurances about nationalization and import/export regulations. Under a comprehensive tax reform law passed in 1981, companies covered by the law enjoy a tax holiday of 5 years; they are excused from all taxes on income and distributed profits for a period of 5 years from the year following commencement of the project. This exemption also covers reinvested profits, special reserves, and undistributed profits earned during the 5-year period but not distributed until later. Foreign employees under Law 43, moreover, are not subject to a general income tax; instead, they pay special purpose taxes associated with it. Law 43 enterprises are subject to few foreign exchange controls and are guaranteed against nationalization or expropriation of private property. And while Egypt's export-import regulations were liberalized in 1975 for the business community as a whole, Law 43 companies enjoy further exemptions.

In addition to these incentives, Law 43 stipulates a number of regulations governing types of technology transfers permitted and other performance requirements. The benefits of Law 43, with few exceptions, are available only to foreign investors who set up joint ventures with Egyptian companies (public or private) or Egyptian individuals. According to Article 3 of Law 43, foreign investment must first of all be in projects requiring international expertise and foreign capital and must fall into categories contained on the list prepared by the General Authority and approved by the Council of Ministers. Projects proposed in the fields and activities not included on such lists may nevertheless be considered when they are of particular importance to the development plan and general policy of the state. Law 43 gives special priority to projects that will generate exports, reduce the need to import basic commodities, and stimulate regional development. For example, it encourages foreign investment in construction outside of the major cities, like Cairo and Alexandria, and especially in newly created "free zones."[29]

Egypt has recently become more encouraging of joint ventures. In general, approved projects must involve some Egyptian participation—although apart from classes involving local currency banks, construction contracting projects, and technical consulting firms, there is no legal minimum percentage.[30] This contrasts with the investment incentive laws of many of the other countries under study that impose strict limits on the extent of foreign participation (generally 49 percent) in all but very high-risk projects. Nonetheless, in practice Egyptian leaders emphasize projects involving majority Egyptian participation.

Saudi Arabia, Prerevolutionary Iran, and Kuwait

As in Egypt, legislation in many of the oil-rich states, such as Saudi Arabia and prerevolutionary Iran, has also been designed to attract foreign investment. While financing is less a concern for these countries, foreign investment is encouraged as a means of gaining foreign technical and managerial expertise.

In Saudi Arabia, joint ventures are viewed as a means of encouraging Saudi involvement in industrial development, and firms with Saudi partners are given preference in contract awards. The Saudi Government therefore provides significant incentives for forming joint ventures. The government provides up to 60 percent of the financing for new industries at 3 to 6 percent interest rates. The Saudi Government formerly offered crude oil supplies at a rate of 500 barrels per day (bbl/d) for each $1 million of actual investment by a foreign partner in petrochemical projects. While SABIC no longer offers crude oil incentives, several benefits remain: low-cost loans, infrastructure benefits, and tax holidays.

In prerevolutionary Iran, foreign investment was also encouraged, largely through the Law for the Attraction and Protection of Foreign Investment (1955) and the Law for Broadening the Industrial Ownership Base (1975). In addition, a series of bilateral agreements with the United States (the Mutual Security Act of 1954), West Germany (the Promotion and Reciprocal Protection of Investments, 1965, retroactive to 1955), and (after 1973) with Great Britain, Italy, and France were negotiated to foster foreign investment and other goals.

Saudi Arabia and Iran have also instituted a number of restrictions. Saudi planners have begun to exercise greater selectivity in projects, favoring manufacturing enterprises. Foreign commercial representation is limited to Saudi nationals, and Saudi law stipulates that preference be given in contract awards to joint ventures more than 51 percent Saudi-owned. And a recent resolution by the Council of Ministers requires that 30 percent of the work under Saudi Government contracts must be subcontracted to local Saudi contractors. While this resolution has been somewhat controversial and serious questions remain as to interpretation, it reflects a growth of regulations encompassing foreign employment, training of indigenous workers, tendering of bids and technology transfer.[31] Iranian legislation prior to the revolution governing technology transfer did not stipulate 51 percent ownership, but administration of Iranian law made it impossible to create wholly owned subsidiaries there and was increasingly explicit in limiting foreign equity holdings.

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[29] Law 43 establishes free zones, where foreign companies are generally not only free from host government regulation, but are offered a number of incentives as well. As the Egyptian Investment Authority notes, "the free zone concept is a key component of the Egyptian Government's plan to stimulate export-oriented industries, and was therefore designed for investors who plan to export the majority of their production." In contrast to other Law 43 enterprises, free zone ventures do not require Egyptian capital participation; they may be 100-percent foreign owned. They also enjoy special incentives, especially in tax exemptions, exemptions from customs duties, and freedom from certain exchange control restrictions. For example, a free zone project is exempt from all Egyptian taxes. Instead, it pays an annual fee equal to 1 percent of the value of its goods entering or leaving the free zone, and it pays rent.

[30] Banking ventures which plan to engage in local currency transactions must be at least 51 percent Egyptian owned. Likewise, construction and contracting projects and technical consulting firms must have 50 percent and 49 percent Egyptian participation respectively.

Kuwait has for some time generally been somewhat more restrictive of foreign investment than have Saudi Arabia or prerevolutionary Iran, although Kuwait is considered to have a liberal trade policy. Kuwait's Industrial Law of 1965 limited foreign commercial representation to Kuwaiti nationals, generally limiting foreign entry to Kuwait and raising the cost of doing business there. The Law of Commercial Companies (1960) requires a majority Kuwaiti interest in all forms of business enterprise. In joint ventures, 51 percent of the capital in a joint venture with a foreign partner must be Kuwaiti, and any non-Kuwaiti participant must be guaranteed by a Kuwaiti. In addition to these restrictions, however, Kuwait has also extended a number of incentives to investors—in areas such as tax and customs duty exemptions, profits, tariff protections, and government purchases.

Algeria and Iraq

Toward the other end of the spectrum are Iraq and Algeria, where restrictions are more stringent. But there are signs this situation may be changing. The overarching law affecting technology transfer in Algeria is the 1966 Investment Code, as amended in 1982. The law, as amended, allows for foreign companies to invest in the Algerian manufacturing sector as joint venture partners with Algerian state-owned firms. New legislation proposed by the National Assembly in 1983 introduces new economic incentives for joint ventures such as tax holidays and special tax treatment for reinvested profits. These proposals also permit foreign firms to repatriate the distributed portion of their net annual profits, but the amount is not to exceed 15 percent of the value of foreign equity in the investment. These incentives are designed to encourage the acquisition of new technology that may be more "appropriate" for the new enterprise's success and profitability, and to thereby avoid expensive imports and acquisitions that the foreign firm may have sold to the Algerian firm if it were operating independently. In the area of management, these incentives encourage in-house sharing of managerial skills between the new partners in an attempt to make the state-owned sector more efficient in the long run.

The Algerian Government also stipulates several conditions in its contracts with foreign suppliers: 1) the suppliers must guarantee the quality of the final product they contract for; 2) the bona fide offers of foreign firms must be guaranteed by the foreign supplier's government against bankruptcy, default, or failure to honor the terms of the contract; and 3) the training of Algerians must be mandated in every contract. (This is also true in many of the other countries; see below.) In addition, the following conditions are also stipulated: 1) all joint ventures must allow for local manufacturing and licensing and must contain provisions for introducing new technology or know-how to Algeria; 2) joint ventures must be made with state-owned companies; and 3) a detailed contract (protocole d'accord) must be drawn up before a joint venture is entered into, which must include licensing and training provisions but which cannot set production limits or fix prices for products manufactured. Foreign firms cannot be granted a monopoly in Algeria.

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[31] See H. Richard Dallas, "The 30 Percent Rule: Understanding and Complying With Resolution No. 124," *Middle East Executive Reports*, March 1984, pp. 9 and 21-4. See also "Saudiization: The Emerging Trends," *Middle East Executive Reports*, June 1984, p. 16. The article reports that an Offset Committee has been established to promote technology transfers in advanced technology sectors.

In Iraq, legislation and regulations concerning technology transfer are more restrictive. The basic law covering mechanisms for interacting with foreign firms in Iraq is the Commercial Company Law No. 31 of 1951, as amended. This law provides the structure for the formation and management of partnerships, companies, branches, or agencies of a foreign company. The few joint ventures involving foreigners in Iraq are involved primarily in special projects in technical fields. For these projects, three forms of partnership are recognized by Iraqi officials: collective company (general partnership), commandite company (limited partnerships), and partnership at will.

Local Agent Laws

The use of local agents is an important, and often required, means of winning contracts throughout some countries of the Middle East, such as Saudi Arabia and Kuwait. Where required, such agents are used to garner political influence in bidding contracts. Their role, however, has generally been expanded to involve assuring contract performance and maintaining continuing client relationships. Hiring well-placed agents, therefore, has been one of the most important means of penetrating new markets for firms with little prior experience in a country.

The Saudi Agent Law, for example, specifies that every foreign company must be registered through a Saudi agent, meaning either a Saudi company or corporation. A foreign contractor who has no Saudi partner must have a Saudi service agent. The only exception is in the provision of sales and services to the Saudi Ministry of Defense and Aviation. Kuwait's New Commercial Law of 1981 also requires that all business conducted in Kuwait be carried out through a Kuwaiti agent or through a Kuwaiti majority-owned company. An exception might be made for consultants and engineers, as long as they are not offering management services; otherwise, they, too, must have a local agent.[32]

Elsewhere, the use of agents is greatly limited, if not specifically proscribed, by law. In Algeria, for example, the use of agents is prohibited by law, since all foreign trade is transacted by the government or the national companies. Use of agents is governed by the "foreign intermediaries" law of February, 1978, which explicitly proscribes the use of foreign agents for foreign firms in Algeria that might solicit contracts. Foreign suppliers are required to sign an affidavit certifying that they did not use agents.

Licensing

For all of the countries under review, a relatively small share of technology transfer occurs through direct licensing to local firms, and most technology transfers occur between joint venture partners or within a multinational to a subsidiary in the Middle East. As discussed in chapter 4, technology transfer to the Middle East has occurred largely through technical service contracts, which were valued at $4.4 billion during the 1978-82 period (see table 30). Even in petrochemical production, where large payments for licenses have been made, these have been associated with large projects which include construction, project management, training, and operations and maintenance. Transfer of know-how to developing countries in the form of technical assistance has grown in recent years, but it is in many cases impossible to assess the value of discrete payments for patents or licenses.

Some Middle Eastern recipient nations have introduced restrictions both in the magnitude of licensing payments allowed by law and in the structure of the licensing agreements themselves. For example, in many of the countries under review, foreign investment laws place limits on the amount or rate of licensing payments and place restrictions on patents and trademarks. In Egypt, which is itself an exporter of technology to other Middle East countries, protection for patents is granted for 15 years initially, renewable for 10 or more under certain circumstances.[33] Algerian Patent Law (Ordinance No. 66-54 of Mar. 3, 1966) specifies a 20-year period for which patents of inventions will be issued. In Algeria, patents of invention must be used within 3 years from their grant or 4 years from their filing date, whichever is later.

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[32] See Quentin Fleming, *Guide to Doing Business on the Arabian Peninsula* (New York: Amacom, 1981), pp. 51-57. See also "Saudi Arabia: Commercial Agency Law," *Middle East Economic Digest*, Apr. 4 and 27, 1984.

Like foreign investment, moreover, the structure of licensing agreements has changed as well. Although licensing agreements are formally vehicles for the simple sale of a license or patent, today they have come to represent a complex package of increasingly high technological and managerial proportions. Broadly speaking, there are two ingredients in a technology license agreement: the transfer of patent, trademark, and other rights and the provision of technical and managerial assistance to a licensee. The majority of technology transfers include organizational and production management assistance as well as the transference of rights and documentation, so that the recipient country will be able to translate the rights and technical documentation into viable production output. In many Middle Eastern countries, the proportion of technical and managerial services in licensing packages is relatively high. In Algeria, for example, the "technical services paid for by enterprises" component of technology license payments amounts to 70 to 80 percent of the total. In most cases, however, only scanty information is available on payments for licenses and patents.

Islamic Law

Another aspect of Middle East law which may affect technology transfer is that found in the *Koran*.[34] All of the countries in the Islamic Middle East adhere to Islamic tenets in their judicial system. Approaches differ, however: Saudi Arabia emphasizes comparatively strict adherence to *shari'a* (sacred Islamic) law, while Kuwait has developed a system of codified laws seen as consistent with Islamic texts.[35] Islam has often been a unifying force in regional efforts at cooperation in technology transfer and scientific research, and efforts have been made to promote "Islamic science."[36] But in all of the countries under review—with the possible exception of Iran—the role of Islamic law has not been significant in technology transfer and has not been a constraint to the notion of technological change. In Iran, justice systems are based entirely on precepts and interpretations of Islamic law. But even here, there have been controversies concerning the meaning of these precepts for technology transfer, reflecting varying interpretations of Islam.[37]

FINANCING

For the six countries under review, paying for technology imports has posed less of a problem than it has for most developing countries. Stated in simple terms, financing involves allocation of revenues among various development priorities, decisions which in turn determine patterns of technology transfer. One facet of the issue is whether a country's exports during a given year are sufficient to cover imports, as indicated in current account balances. Because all of these countries depend on oil exports as a major source of revenues, as indicated in table 96, they have all been challenged to adjust to a period of lower oil revenues in the early 1980's. Related issues involve the degree and type of dependence on foreign sources of funding (including aid), as well as policies concerning foreign investments and use of foreign reserves. Finally, the capabilities of domestic financial and commercial institutions (public and private) influence exchange rates as well as capital formation domestically. The discussion that follows focuses primarily on the first two sets of issues involving the relationship of the economies of recipient countries to foreign sources of capital and investment.

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[33] "By taking a flexible approach," the Investment Authority states, "the government is trying to make it as easy as possible for Egyptian private and public sector industries to get the benefits of useful new technology." The General Authority for Investment and Free Zones, *The Official Guide to Investment in Egypt*, op. cit., p. 40. For discussion of Egypt's role as a technology exporter, see Tagi Sagali-Nejad, "Transfer of Technology From Egypt," paper presented at American Economic Association, New York, Dec. 28-30, 1982. For UNIDO estimates of technology transfer to developing countries, see United Nations Industrial Development Organization, *Second World-Wide Study of the Petrochemical Industry*, May 19, 1981, ID/WG. 336/3, p. 275.

[34] The sacred text of Islam.

[35] See Herbert J. Liebesny, *The Law of the Near and Middle East* (Albany, N.Y.: State University of New York Press, 1975), pp 107 and 111.

[36] See "Riches and Poverty in the Muslim World," *Financial Times*, July 12, 1977, p. 15; and Ziauddin Sardar, *Science, Technology and Development in the Muslim World* (London: Croom Helm, 1977), passim.

[37] See Riad Ajami, *Arab Response to the Multinationals* (New York: Praeger Publishers, 1979), pp. 136-137.

With regard to their capabilities to finance development projects involving technology transfer, these countries fall into two groups: those that finance with and those that finance without foreign assistance. For the oil-rich countries of the Middle East, such as Saudi Arabia, Kuwait, Iran, and Iraq, imports have been financed without assistance from foreign official credit agencies. As shown in chapter 2 in table 1, these four countries built up sizable cumulative current account surpluses in the 1973-80 period. As oil revenues have recently fallen, financing has become a concern even for these countries, but as discussed in chapter 3, most of them still have large reserves and investment incomes.

For those countries whose exports and reserves have not been sufficient to cover imports and debt service, such as Egypt and Algeria, questions of financing technology transfer have been very important. Both Algeria and Egypt accrued cumulative current account deficits of approximately $10 billion each during the 1973-80 period. The Iraq-Iran War has reduced Iraq's oil exports and led to a drawdown in reserves, with the result that beginning in 1981 the country was unable to cover imports with exports. Iraq, thus, in the short term has joined the group of countries where financing is a major problem. Despite the common concern about financing among these countries, their approaches to financing technology imports differ, with Algeria presently relying primarily on hydrocarbon exports; Egypt, on foreign aid and borrowing in addition to oil exports and remittances; and Iraq, on producer credits and the reshaping of financing terms, long-term commitments for oil puchases, and loans from other Arab countries.

Egypt

Very little financing for development projects in Egypt now comes, or will come in the immediate future, from the national budget. Instead, the current pattern is to finance technology transfer through debt (medium or long term), government-to-government financial assistance, international donor grants or loans, or supplier financing in the form of concessionary loans. Accordingly, Egypt is most dependent on external sources of financing. U.S. economic assistance (of about $1 billion) and aid from other Western nations to Egypt amounted

Table 96.—Oil Exports and Government Revenues, 1980

Country	Oil exports as percent of total exports	Oil exports as percent of GDP[a]	Oil revenue as percent of government revenue[b]
Saudi Arabia	96.3	72.4	89.3
Kuwait	99.9	87.8	91.2
Iraq	99.2	65.1	85.2
Iran	94.4	16.3	64.3
Algeria	91.8	30.8	55.4
Egypt[c]	23.0	7.4	20.0

[a] 1980.
[b] 1979 (Iraq—1977, Iran—1978).
[c] Net oil exports.

SOURCE: Jahangir Amuzegar, *Oil Exporters' Economic Development in an Interdependent World* (Washington, D.C.: International Monetary Fund, 1983), taken from table 2, p. 11.

together to more than $2 billion annually in the early 1980's.

Egypt has been seeking to facilitate financing of technology transfer through revitalization of private sector banks, encouragement of foreign development banks, and efforts to maintain levels of remittance flows. Because the banking industry is dominated by public sector banks, the main form of financing is that negotiated by the central government and arranged for through the four public banks. After a restructuring of the banking system since 1973, private banks now sometimes play a role in financing projects involving technology transfer. The new Cairo Hospital, for example, a $30 million project, is a combined Kuwaiti-Egyptian investment with a scheduled 25 percent return on investment and a 3- to 5-year payout.[38]

Investment banks also play a limited role in financing technology transfer to Egypt. While there were few offshore banks in Egypt prior to 1973, Law 43 created a much expanded group of investment and business banks. As of 1981, there were 25 special banks registered with the Central Bank, of which 17 were branches of foreign banks, and 8 joint ventures with a growing loan portfolio and deposit base. These banks may establish investment companies and, with 51 percent Egyptian ownership, may also operate with local currency. But while this group of investment and business banks has experienced enormous growth in Egypt, their investments have been more in tourism and real estate than in capital projects.

Photo credit: U.S. Agency for International Development

Baking bread in Egypt. U.S. Public Law 480 assistance provides wheat and flour to Egypt, while efforts are made to increase agricultural output of Egyptian farmland

The Egyptian Government is reportedly attempting to ensure the continued flow of remittances, a major source of foreign exchange earnings. Under an agreement reportedly concluded with Iraq, remittances from Egyptians working in Iraq will be regulated through Egyptian public sector banks, to assist Egyptian workers to remit their earnings from Iraq and to create more foreign exchange in Egypt's commercial bank pool.[39]

Thus, the base for more extensive financing of the purchase of technologies has expanded in Egypt in the past 9 years, but Egypt remains dependent on foreign aid and borrowing. The extent to which other domestic sources of financing will serve that purpose more extensively in the future depends in part on reform of the public sector and growth in the private sector.

Algeria

Although none of the countries under review rank among the more extreme LDC debtors such as Brazil or Mexico, Algeria, like Egypt, has also incurred large debts during the past two decades. However, Algeria has recently attempted to turn away from foreign aid and borrowing. Instead, present Algerian policies stress that the main sources of financing should be exports of natural gas and crude oil, followed by increased private investment and binational loans. Indeed, since 1980, Algeria imposed a moratorium on foreign borrowing. Organizations such as the International Monetary Fund or the Common Market are no longer major lenders. In the present 5-year plan, 60 percent of funds for investments are expected to come from the foreign exchange earned from estimated annual revenues of $12 billion from petroleum and natural gas.

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[38] Loans covered 70 percent of costs ($12 million) and were provided by a consortium of private banks at an interest rate of 11.5 percent for a 7-year period.

[39] "Pact to Raise Workers' Remittances From Iraq," Cairo, MENA, in Arabic, Aug. 20, 1983 reported in FBIS.

The explanation for this policy must be traced to the high government debts accumulated during the 1970's. During the 1960's and 1970's, public enterprises accumulated enormous debts which were financed in large part by advances from the treasury. By 1980, the national enterprises had accumulated bank debts of almost $5 billion, and the manufacturing sector alone accounted for almost $3 billion of this debt. Since 1978, the Algerian state has held a monopoly over foreign trade. The sociétés nationales and the government ministries have been the exclusive importers of foreign technology and have been financed by resources from hydrocarbon revenues and by foreign loans and grants of credit.

In 1980, the Chadli government made it official government policy that hydrocarbon revenues be used effectively to stimulate production.[40] One major effect of this decision was practically to eliminate international borrowing by state enterprises in 1980-82. In 1983, however, Algeria turned to the World Bank and Arab funds for financing.[41]

Emphasizing hydrocarbon exports as the major source of foreign reserves, Algeria's financing policies have been strongly related to oil prices. Like Nigeria and Venezuela, Algeria has gained a reputation as a "maverick" within the Organization of Petroleum Exporting Countries (OPEC) by frequently demanding higher than agreed-on OPEC prices per barrel of crude oil,[42] but has usually succeeded in selling all oil lifted to foreign purchasers. Recently, exports of natural gas have offset any shortfall Algeria may have felt from the slack oil market in the early 1980's. Because of an impressive hydrocarbon production record, Algeria will probably continue to enjoy relatively easy access to international lending markets at favorable interest rates throughout this decade. Long-term prospects hinge on Algeria's ability to expand nonoil revenues to replace dependence on hydrocarbon exports.

Iraq

Iraq is a newcomer to heavy borrowing. During the 1970's, foreign reserves grew. Beginning in the late 1970's, however, the situation began to change, and the war with Iran has rapidly depleted foreign reserves. According to one estimate, Iraq's $12 billion surplus in 1980 fell to an annual deficit of $8 billion to $10 billion by 1983.[43]

In light of dramatically declining reserves caused by war expenditures and declining oil revenues, Iraq has turned for financing to producer credits and to long-term commitments for oil purchases. In addition, the Iraqi Government has relied on substantial external borrowing. In contrast to the early pattern of reliance on loans from the Soviet Union and Eastern Europe, major support has been provided by neighboring Gulf States, including Kuwait, Saudi Arabia, and the United Arab Emirates (UAE) in the form of interest-free loans, repayable over a period of 10 years. It was estimated in early 1983 that these loans totaled $25 billion for the period since the inception of hostilities with Iran. For Iraq, in particular, the war with Iran and a slack oil market have seriously affected the country's ability to finance civilian technology transfer.

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[40] Algerian economist Bennisad wrote recently "the international solvency of Algeria resides in her present, in her revenues from the exploration of oil and in the immediate future in the execution of contracts for the export of natural gas." See M. E. Bennisad, *Economie du Developpement de l'Algerie*, sous-developpement et socialisme, 1962-82 (Paris: Economica, 1982), p. 252.

[41] As discussed in ch. 3, total debt has remained high: in 1981 the total estimated disbursed external debt was $17.5 billion, and the debt service was estimated at 25 percent of imports. In 1983, Algeria's $4 billion in foreign debt service payments amounted to 34 percent of its exports. The debt service ratio is expected to fall in 1984 and thereafter. See Nigel Harvey, "Algeria," *Middle East Economic Digest*, May 4, 1984, p. 52.

[42] For a brief period in 1981, Algeria received $40 per barrel for her premium "sweet" crude (i.e., low-sulfur content petroleum). In 1982, after extensive negotiations, Algeria eventually reduced its price per barrel to $37.50, which was more in line with the OPEC price of $34 per barrel.

[43] Tom Sealy, "West Germans in the Iraqi Quagmire," *Financial Times*, Oct. 17, 1983.

Saudi Arabia

Saudi Arabia's oil export revenues allowed for increased expenditures on technology transfer in the 1970's. In recent years, however, financing has become a more salient consideration. By the early 1980's, public spending was tightly restrained, affecting the volume of business in all sectors. The government cut spending in the fiscal year 1982-83 (ending April 1983) by 15 percent compared to the previous year's actual level. During that period, Saudi Arabia sharply reduced its contracting.

In April 1984, the Saudi Arabian Government announced plans for a $74 billion budget, the same level as the previous budget which was underspent by 14 percent. Income is budgeted at $61 billion. The deficit is to be financed by drawing down reserves.[44] The current period of greater austerity has been marked by several measures affecting technology transfer, efforts to improve the cost effectiveness of government expenditures, and a salary and recruitment freeze for public officials. While reserves are still large, more concern surrounds the effective management of this wealth.

These trends set a context for increasing involvement by commercial banks. The central bank of Saudi Arabia, the Saudi Arabian Monetary Authority (SAMA), has in the past dominated lending for local industrial projects. SAMA has introduced measures designed to promote the growth of commercial banks. Saudi Arabia's fiscal policy has been conservative and rather tightly controlled.

Kuwait

Kuwait has followed largely the same pattern as Saudi Arabia, by adopting stringent fiscal policies in 1981. Government subsidies were gradually reduced, and a fundamental change occurred in the overall way in which budgets were prepared. Since the 1982-83 budget, only schemes that are ready to go into effect have been included in the development budget, and funds are budgeted in a much more discriminating way than before.

As an aspiring regional financial center, Kuwait has an extensive banking system, comprised of the central bank and an array of commercial banks, specialized banks, and several major nonbank financial institutions.[45] As discussed earlier, these often play a major role in financing development projects. In addition, the Kuwait Fund for Arab Development has provided major funding for development projects in other countries. Unlike Egypt, few foreign banks operate in Kuwait; most of the commercial banks are totally Kuwaiti-owned. Instead, services for particular banks in Kuwait, for example, have been provided by foreign banks such as the Chase Manhattan Bank (for the commercial Bank of Kuwait) and the Credit Lyonnais of France (which oversees the operation of the al-Ahli Bank). Generally speaking, foreign banking in Kuwait is internationally oriented, as evidenced by operations of the Islamic Development Bank, the Non-Aligned Fund, the Afro-Arab Development Bank, and OPEC and Organization of Arab Petroleum Exporting Countries (OAPEC) facilities. The Kuwaiti stock market collapse in 1982 may have tarnished the credibility of the Kuwait market, but few direct effects on technology transfer have been noted.

Iran

Prerevolutionary Iran saw little need for foreign financial aid in connection with technology transfer projects. Generous loans, grants, and concessions provided by the government and private banks to the private sector alleviated the need for large-scale external financing by individual firms. According to the last annual report of the Industrial and Mining Development Bank (IMDBI) prior to the revolution (1977-78), the bank had a total investment of nearly $4 billion in firms that it helped establish.[46] In addition, about 30 public and private banks, some in collaboration with U.S. banks, also provided capital for new ventures and for expansion projects. By the late 1970's, however, Iran experienced a mild recession, and some projects were scaled back. Since the revolution, Iran's situation has changed dramatically, but the country has been in a position to maintain oil exports. With continuing oil revenues and expanded barter and other arrangements, imports expanded again in 1983 after falling precipitously in years before.

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[44] "Pressures Mount on Public Spending," Special Report on Saudi Arabia, *Middle East Economic Digest*, July 1983, p. 8. See also "Saudi Budget Signals a Thaw," *Middle East Economic Digest*, Apr. 6, 1984, p. 47.

[45] For an excellent description of Kuwait's banking system, see R. El Mallakh and Jacob A. Ata, *The Absorptive Capacity of Kuwait* (Lexington, Mass.: Lexington Books, 1981), chs. 3 and 4.

Thus financing technology imports has become a major concern for these countries, the Gulf States included. The terms offered by foreign suppliers are an increasingly important consideration as is long-term productivity of investments, both domestic and foreign.

MANPOWER POLICIES

The policies of all of the recipient countries attempt a balance between reliance on foreign labor needed for rapid economic development, and the training and use of a native labor force to shape that development in the future. Manpower issues are most pronounced in countries such as Saudi Arabia and Kuwait, where labor resources in general, and skilled labor in particular, are most scarce. Egypt marks the other extreme, where a large, relatively skilled population and an extensive network of educational institutions already exist. There, the key policy issues include emigration of indigenous skilled personnel to other countries of the Arab world and effective utilization of trained manpower at home.

Employment of Foreign Workers and Project-Level Training

In an immediate sense, manpower policies affecting technology transfer are felt most directly at the project level. All of the countries under review have established regulations that limit the participation of foreign personnel and require foreign companies to train indigenous workers. In general, these regulations have been relatively successful in assuring participation by indigenous personnel. They have, however, brought problems as well: because of a frequent dearth of indigenous personnel willing or able to participate in certain sectors in some of these countries, enforcement has often been lax; and where such regulations have been enforced, they have often led to redundancy and sometimes even delays in indigenous skill development. While in recent months a downturn in economic growth in Gulf States has led to an exodus of foreign workers, the long-term challenges of establishing policies that regulate the involvement of expatriate labor will remain.

The Saudi Labor and Workmen Law of 1969 (the "Labor Law") requires minimum percentages of Saudi employment in all foreign enterprises working in Saudi Arabia. According to this law, a firm's workforce must be 75 percent Saudi and at least 51 percent of its payroll paid to Saudis, but these requirements are often reduced when a sufficient number of skilled Saudis is not available.[47] It is difficult to assess the degree to which such regulations have been enforced, or the success of training programs. The case of ARAMCO stands as a relative success, because indigenous Saudis have continued to move up the ladder and assume many high-level managerial and technical posts. In fact, ARAMCO's management training program served as a model for Saudia Airlines. In other cases, however, the result has been labor redundancy in joint ventures, as total employment levels have been raised to accommodate greater numbers of indigenous personnel and skilled foreign workers, since it is often impossible to recruit enough Saudis with appropriate skills. Foreign firms have reportedly faced delays in obtaining ap-

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[46] See IMBDI, Annual Report 2536, 1977-78 (Tehran: IMBDI, 1978).

[47] For a discussion of the Saudi Labor Law, see Paul Herzog, "Problems Commonly Confronting Employers Under the Saudi Labor and Workmen Law," *Middle East Executive Reports*, July 1979, p. 2. See also Laron L. Jensen, *Marketing in Saudi Arabia*, U.S. Department of Commerce, *Overseas Business Reports*, December 1979, pp. 37-39.

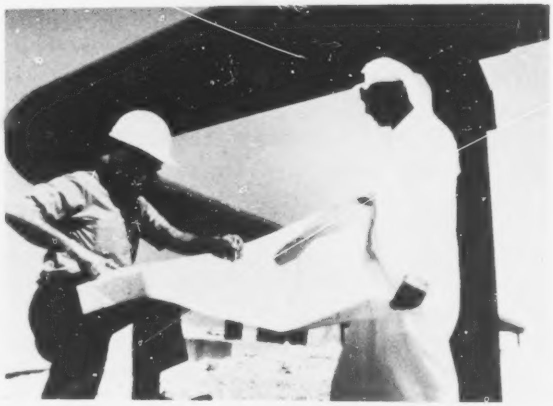

Photo credit: Aramco World Magazine

ARAMCO employees in training session

proval for exemptions when qualified Saudis could not be found.

Similar employment requirements are found in Egyptian law, and there a trend toward increased stringency is apparent. Egyptian regulations stipulate that no more than 25 percent of the personnel of foreign companies in Egypt may be expatriate. Proposals were under discussion in 1983 to stop issuing work permits to foreign companies if more than 10 percent of their staff is expatriate.[48]

Likewise, Kuwait has regulations requiring foreign companies to hire Kuwaitis for 25 percent of their work force. Partly to enforce this, foreign companies in Kuwait require a "No Objection Certificate" for every new employee. In many cases, these regulations have been regarded as mere formality, and the Ministry of Commerce and Industry often waives the first requirement if no qualified Kuwaitis are available. Two factors distinguish the Kuwaiti approach. First, the early decision to permit women to work gives Kuwait a broader labor base than that of, for example, Saudi Arabia. Secondly, Kuwait's strategy of equity acquisition in foreign firms also has manpower implications. At Santa Fe International, the hope is that the training of Kuwaitis will lead to the development of a permanent high-level career track. So far, there have been no apparent pressures to integrate Kuwaitis quickly into the actual operations of the company, and company headquarters and main base remain in the United States. But in the opinion of one senior Santa Fe official, the seconding of personnel for combined training and integration will take place naturally and over a long period of time. The Chairman of the Board, Shaikh Abdul Malik Gharabally, is a Kuwaiti and an experienced petroleum official.

In other Middle Eastern countries, regulations and laws concerning foreign manpower at the project level have in principle been equally stringent, but their enforcement has often been more lax. In Iraq, for example, Regulation No. 30 of 1973 prohibits foreign labor in excess of 10 percent of the work force of a project. Because of the demand for technicians and managers to relieve war-caused labor shortages in development projects, however, exemptions for skilled labor can usually be obtained. In contracts with foreign companies, most machinery and equipment exporters are required to establish maintenance centers in which to train Iraqis, and the foreign exporter must supply 25 percent of each center's training staff. The centers are to be supervised by public sector companies for 10 years, after which they are to be bought by the Iraqis. Companies supplying computers must ensure that training is given to operators and maintenance engineers, and manufacturers are also sometimes required to set up regional support centers.

In other Middle Eastern countries, such as Algeria, regulations on foreign labor have generally been even more lax and the policies ill-defined. Today, however, Algerian policies governing foreign employment are now being refined to deal with the growing number of foreign personnel operating and constructing new facilities and plants. Some Algerian planners argue that this has inhibited development of an indigenous expertise. By 1978, more than 86,000 foreign technicians were employed in Algeria.[49] In Algeria, responsibility for training has been shifted to the foreign contractor. Algerian leaders believe that the immediate need "is for maintenance workshop and services within each corporation or group of corporations."[50] Algeria's 1980-84 plan provides for a national apprenticeship program to encourage onsite training. The government intends to expand technology transfer requirements in contracts, such as requiring contractors to train local staff to run the plants that they establish. This relatively new trend in contracts developed from a dissatisfaction with turnkey contracts wherein plant and equipment was provided without the expertise to operate them.[51]

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[48] See Colin MacKinnon, "Egypt's Not Issuing Work Permits," *The Middle East Executive Reports*, October 1983, p. 7.

[49] J. Minces, *L'Algerie de Boumedienne* (Paris: Presses de la Cite, 1978), p. 50.

General Education and Training Programs

From a national perspective, building a technically skilled indigenous manpower base has been a major concern. Efforts have concentrated on expanding the general educational level of the population; creating new institutes and organizations to transmit technical skills; expanding technical skills by sending students for training abroad; providing greater incentives to attract indigenous populations to enter technical fields, and facilitating better job placement on graduation. Despite these efforts, however, many problems remain, and these policies will continue to demand revision and reevaluation in the years ahead.

Table 97 illustrates the substantial expenditures spent on education in the countries of the Middle East. The Arab countries spent an average of 15 percent of the government budget for 1977-78 on education, ranging from 13 percent in the oil-rich countries to over 22 percent in the oil-poor countries. By 1975, educational expenditures in the Arab world, per capita and per student, had grown to a level considerably above the average for LDCs worldwide.[52] Emphasis was placed especially on scientific and technical education.

Middle Eastern Technical Training.—All of the countries under review are attempting to expand their national system of technical education, often with foreign assistance, but approaches have varied widely. Efforts to develop an educational infrastructure, especially in the scientific and technical fields, have been

Table 97.—Total Expenditures on Education Per Capita in the Middle East, 1970-75[a]

	U.S. dollars per capita			U.S. dollars per enrolled student[b]	As percent of all public expenditures	
Country	1965	1970	1975	1975	1970	1974
Developed countries	140	268	636	1,227	—	—
LDCs	7	19	47	110	—	—
Arab world	14	51	102	324	—	—
Oil rich[c]	24	197	226	1,085	—	—
Oil-poor[d]	11	21	77	134	—	—
Selected Arab countries:						
Iraq	18	30	119	142	20.4	8.9
Kuwait	132	346	674	1,616	11.8	14.7
Saudi Arabia	19	471	284	3,637	9.8	8.2
Algeria	19	37	124	211	12.9	14.3
Egypt	10	17	61	98	14.6	17.6
Syria	11	26	52	115	9.3	8.5

[a] Per enrolled student and as a percentage of current government expeditures.
[b] This column includes all students enrolled in the primary, intermediate, secondary, and higher levels.
[c] Comprised of eight countries: Bahrain, Iraq, Kuwait, Libya, Oman, Qatar, Saudi Arabia, and the UAE.
[d] Comprised of 12 countries: Algeria, Egypt, Jordan, Lebanon, Mauritania, Morocco, Somalia, Sudan, Syria, Tunisia, North Yemen, and South Yemen.

SOURCE: Paul Shaw, *Mobilizing Human Resources in the Arab World* (London: Kegan Paul International, 1983), p. 165, compiled from UNESCO, *Statistical Yearbook*, various volumes.

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[50] A. Benachenhou, "Foreign Firms and the Transfer of Technology to the Algerian Economy" (Geneva: International Labor Office, October 1976), p. 26.

[51] For example, in the Societe Nationale de Siderurgie, the Algerian Steel Co., Algerians operating the steel mill will be replaced temporarily by Japanese production workers, with the hopes that Algerian workers will learn by observing the correct methods of operating the mill and will appreciate the impact of the operators' competence on industry performance.

[52] See Paul Shaw, *Mobilizing Human Resources in the Arab World* (London: Kegan Paul International, 1983), p. 162.

especially prominent in Saudi Arabia and Kuwait. Enrollment in Saudi Arabia's 30 technical and vocational training schools rose from about 500 to over 11,000 students during the 1970's, while the number of graduates rose from 500 to 5,550.[53] In 1981, Saudi Arabia's General Organization for Technical Education and Vocational Training (GOTEVT) was established, a merger of the Ministry of Education's technical education department with the vocational training division of the Ministry of Labor and Social Affairs. The organization offers vocational training at all levels. Seventeen new vocational training centers are currently in various stages of construction, with another 11 to be built by 1985; these are expected to more than double GOTEVT's present training capacity of 8,000.

Similarly, in Kuwait, the Public Authority for Applied Education and Training was established to function as an umbrella organization promoting training programs relevant to a number of ministries and sectors. It has a separate budget account from related ministries and aims to encourage teacher retraining in technical fields and student education. The Institute of Applied Technology, under the jurisdiction of the authority has been allocated a $1.5 million budget for programs involving 1,000 students. It has relatively new facilities and offers a number of specialized courses in almost every technical area, as requested by various government agencies. The goal of the program is to develop shop floor managers and to allow students to attend both lecture courses and practical workshop sessions. The Telecommunications Training Institute is illustrative of institutes in Kuwait that are more closely connected with one ministry—in this case the Ministry of Telecommunications. With an enrollment of about 350 students, the institute offers 1- and 2-year courses in areas covering the whole spectrum of telecommunications technologies.

In Egypt, where the numbers of trained personnel and varied educational institutions are relatively high, the emphasis on training is less on expansion as on upgrading and adjusting educational policies to labor demand. Egypt's educational institutions are comparatively extensive. In 1977-78 there were 179 higher education institutes with over 23,000 teachers and 550,000 students in Egypt. In Egypt, universities are overcrowded and the quality of education has suffered, partly as a result of policies that have emphasized open admissions. While vocational and technical education have not been stressed as much as university education, the present plan of the Ministry for Higher Education and Scientific Research calls for building 25 technical schools and 6 more secondary schools, using some World Bank Funding.

To develop industrial skills, specialized institutes of postgraduate studies have also been established in different branches of Egyptian industry, such as the El-Tebbin Institute for metallurgical studies. In addition, other measures have been introduced to reduce the shortage of skilled manpower in industry, such as establishing specialized applied research centers to provide technical training and to contribute to the technological development of industry (e.g., the Centre for the Development of Textile Industries), and raising the amount and proportion of investment allocated for vocational training in the 5-year plan through the Ministry of Industry.

Algeria is presently in the process of restructuring its entire educational system. Since the Ministry of Higher Education and Scientific Research was founded in 1970, the number of institutes of higher learning has expanded rapidly. The phasing in of a new system beginning in 1975 involved heavy emphasis on vocational and technical education. One major reform is the replacement of the existing primary and middle school system by a technical education course of 9 years, consisting of 3-year cycles; at the end of the second cycle, those with a technical orientation are channeled into preprofessional training schools. Those who complete the third cycle, and remain in the formal educational system, may go on to academic secondary school, specialized technical school, or professional training schools.

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[53] "Kingdom's Vocational Training Bringing Country Closer to Saudiization," *Saudi Report*, August 1983.

By the 1978-79 academic year, Algeria had 22 technical schools, with close to 12,000 students and over 1,000 teachers. The 1980-84 plan allocates approximately $76 million for building professional centers, and additional funds for building and equipping 268 training institutes and 300 vocational education centers. In addition, Algeria also emphasizes the development of technological institutes, conceived in 1964 as a solution to the shortage of qualified middle-level and senior technicians, a shortage exacerbated by the departure of the French following Algerian independence. These technological institutes are intended to attract those who have never had access to formal education and dropouts from the traditional educational system. One such technological institute, the INELEC (the Institut National d'Electricité et d'Electronique) was established with the cooperation of American universities and industrial firms in March 1976 to serve as an institute for training Algerians in electrical engineering and electronics. The American contractor, Education Development Centre (EDC), had the responsibility of recruiting professors and training Algerian teaching staff; 300 students were enrolled in 1978.

Prerevolutionary Iranian and Iraqi policies that involved expansion of vocational and technical education have been disrupted by the Iran-Iraq War and the revolution in Iran. In the 1960's to early 1970's, Iran placed great emphasis on improving higher education facilities and expanding research. Indeed, prior to the revolution, it had attained one of the highest levels of technological development in the Islamic Middle East, and educational development and technology transfer through educational exchange were actively pursued by the government. In 1977-78, there were 224 universities and colleges in Iran, with 146,000 students; there were about three times as many technical vocational schools.

The revolution in 1979, however, and the subsequent outbreak of war with Iraq, have accentuated the shortage of engineering skills in Iran, as many senior and middle-level technicians and engineers left the country, and as the army continues to absorb scarce skills. More recently, it appears that government efforts to expand technical training are again intensifying.

Since the late 1970's, Iraq has placed special emphasis on increasing the number of vocational and technical institutes. In the late 1970's, the number of vocational schools and student enrollment grew rapidly. Between the 1976-77 and 1979-80 school years, for example, the number of vocational school students nearly doubled, from around 28,400 to 53,400. One of the most important efforts was the establishment in 1975 of the University of Technology (UOT) in Baghdad. With the objective of "training most Iraqi and foreign students in scientific, technical, and professional fields of study that are related to the process of economic and social transformation in Iraq,"[54] the University had 8,500 undergraduate students and 200 postgraduates in the early 1980's. The 1980 government program anticipated the establishment of 27 industrial, 17 agricultural, and 15 trade schools, at a total cost of $14.2 million. A technical institute costing $37 million was also planned to open in 1980-81 for 1,560 students in management, accounting, and technology.[55]

The war with Iran, however, necessitated substantial revision of the 1981-85 plan. The impact of the war on the universities is evidenced by the cancellation of foreign university teachers' 1982-83 contracts and the decision to increase the teaching commitments of local university teachers by 50 percent or more; this step is expected to save over $30 million to help finance the war effort.[56]

To support the development of an education and training infrastructure, a number of contracts with foreign firms have been devoted specifically to developing technical training at home. The major projects along these lines range from government-to-government agreements in Saudi Arabia, contracts with independent consulting firms in Egypt, to contracts with private universities in prerevolutionary Iran. Egypt, for example, has made wide use of outside consultants, and many of the new educational facilities are being constructed with foreign assistance—including several AID projects designed to improve the skills of Egyptian scientists and technicians and to solve technical managerial problems. One AID project provides in-house training to Egyptian managers in public and private sectors. The program involves diagnosis of problems, industry-specific training, and application of improved skills in solving specific problems. U.S. consulting firms, such as Arthur D. Little, and university programs, such as those from the Massachusetts Institute of Technology, are active in Egypt. Other projects have involved the World Bank, the European Economic Community, and West European and Japanese firms and governments in design and funding.

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[54] See Dr. Mohammed Shihab, in *The Baghdad Observer*, Oct. 24, 1983, p. 4. Translated in JPRS, Near East/South Asia, Dec. 19, 1983, p. 42.

[55] *Middle East Economic Digest*, June 20, 1980, p. 32; *Middle East Economic Digest*, Feb. 20, 1981, p. 24.

[56] *Middle East Economic Digest*, Sept. 17, 1982, p. 30.

In Algeria, foreign assistance in expanding the vocational educational centers and in providing the necessary personnel and equipment has also been important. Vocational training centers are currently being built by Belgian contractors. A World Bank loan of $87 million supports the construction of three maintenance training schools, three industrial training schools, and an institute for training maintenance trade instructors. The Soviet Union is scheduled to build 10 vocational centers. In Saudi Arabia, some of the most important projects to improve educational and vocational training have been carried out in conjunction with the U.S. Department of Commerce, under the U.S.-Saudi Joint Commission on Economic Cooperation.[57] Kuwait has generally preferred working with specialized outside consultants rather than cooperating on a government-to-government basis in technical training. In prerevolutionary Iran, one of the most important efforts to develop local training programs was conducted by creating links with various American universities. More than 25 American universities were involved in linkage programs with specific Iranian universities.

Iraq's efforts to expand vocational and technical institutes have also involved foreign aid and assistance; foreign contracts have also been used to promote training internally. The Soviet Union has helped establish engineering education, while Scandinavian countries have been involved in setting up technical institutes, and the Japanese and British in other technical projects. Recently, for example, Mitsubishi was asked to establish a technician training center and to provide industrial training, particularly in steelmaking and petrochemical production; the ILO signed a $948,188 contract with the State Organizaton for Labor and Training to train people at Waziriya. A British corporation, Tecqipment Intremath, which has been providing curricula for technical schools in Iraq for several years, has a $4.7 million contract to construct teaching laboratories and to provide in Great Britain training for technical college students and staff.

Another way in which Middle Eastern governments have sought to increase the level of skills and the number of skilled workers has been through government-sponsored training abroad. While little aggregate data are available, growing numbers of Middle Easterners are studying abroad, as indicated by data on foreign students in the United States (see ch. 13). In the 1981-82 school year, there were approximately 56,000 Iranian, and at least 10,000 Saudi students enrolled in U.S. colleges and universities and specialized training programs.[58] Specialized training programs in other countries have also been arranged. For example, 30 trainees from Petromin, the Petroleum and Mineral Organization, recently completed 2½ years of training in West Germany in various technical fields such as industrial mechanics, industrial electricity, handling of delicate equipment, and welding works. The program is sponsored by West Germany's Technical Cooperation Development Agency and is aimed specifically at training Saudi youths in technical subjects associated with the petroindustrial and petrochemical fields.

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[57] The U.S.-Saudi Joint Commission was initiated in 1974 to assist in the internal development of Saudi Arabia through cooperative programs. Approximately 17 U.S. Government agencies have been involved in the commission. The U.S. Army Corps of Engineers has also played an important role in providing technical services.

[58] According to the Saudi Ministry of Planning, about 23,000 Saudi students attended schools of all kinds in the 1980-81 school year. Out of the 211 Saudis who received Ph.D.s abroad during the 1927-74 period, 97 of them received their degrees in the United States. See Al-Farsy, op. cit., p. 164.

Present Challenges.—In short, the range of policies to train local personnel is extensive and varied, including requirements for training associated with specific projects to expansion of general vocational and technical training at home and abroad. Success has been significant, as indicated by the wide range of technical institutes established and the gradual movement of indigenous personnel into positions of responsibility. Nevertheless, significant challenges remain.

One key question is how to provide incentives to attract indigenous personnel to the technical sectors in the first place. Middle Eastern governments realize that technical training programs can be successful only if the local population is willing to participate. As discussed in chapter 3, in most of the countries under review, the indigenous labor force is concentrated in the government or service sectors of the economy, with relatively small proportions entering the scientific and technical fields. This situation is due mainly to two factors: first, a lack of wage and other incentives to enter technical fields; and second, a general aversion to many kinds of industrial and manual labor.

In Saudi Arabia, Kuwait, and Egypt, the government guarantees employment and a minimal wage for every citizen. For Saudis and Kuwaitis, this salary is quite generous, thereby providing little incentive to move to technical fields where the salary difference may be marginal. As a result, indigenous populations have tended to remain in traditional occupations, which are generally viewed as more prestigious. Recent articles in the Saudi press, for example, have noted the "abundance of graduates of the theoretical disciplines and a dearth of graduates of the scientific and applied disciplines."[59] According to these reports, the number of students applying to the scientific departments is "very troubling," insofar as it is far outpaced by the number of those applying to the humanities departments. Similarly, in Kuwait there is still a decided preference for business and finance, and despite the government's training efforts, few Kuwaitis are attracted to technical fields. While the government expands support for technical schools, most Kuwaiti students continue to earn degrees in the liberal arts. In Egypt, where a larger pool of technically trained personnel exists, the comparatively rapid rise in civil service jobs and wages has been a disincentive for Egyptians to enter the technical fields in the private sector.[60] A large number of those who have entered the technical fields, moreover, have subsequently chosen to work elsewhere in the Arab world, where wages are higher.

A second problem is that many students who study abroad may choose not to return home. While data on the number of returnees are limited, in 1977, 1,000 Algerians reportedly were sent abroad to the United States and elsewhere to train in gas and petroleum technology and civil engineering. Although most of these trainees were obliged by the Algerian Government to return home after their period of study, estimates were that the majority chose not to. Other countries throughout the Middle East, including Syria and Iraq, apparently face difficulty in encouraging recent university and technical school graduates to work at home.[61]

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[59] See, for example, "Education Policy Criticized for Not Meeting Development Needs," translation of article in *Al-Yamamah*, Oct. 19, 1983, pp. 3-11; translated in *JPRS: Near East, South Asia*, Dec. 2, 1983, pp. 44-58. A recent study conducted by the King Sa'ud University that only about one-fourth of the graduates from the two universities are from the scientific departments, which comprise 15 colleges (Ibid., p. 46).

[60] See Bent Henson and S. Radwan, *Employment Opportunities*, ch. 12, pp. 227-228. See also Waterbury, op. cit., p. 244.

Still another problem relates to the distribution of trained personnel once they have been graduated. Expanded vocational training does not necessarily solve labor problems. A study in Kuwait conducted by the Ministry of Social Affairs and Labor in 1974, for example, found that almost 50 percent of graduates of vocational and technical training would not accept manual work even though their training was for such positions. In addition, over 86 percent of graduates who did work in their fields of specialization required retraining before they could be employed. In Egypt, employment and wage policies, which do not encourage students to enter scientific and technical fields in the first place,[62] also provide little incentive to remain in Egypt upon graduation. A recent survey showed that as many as 45 percent of the graduates prefer to work for private firms or overseas than to work for the government, despite the fact that many of them do become civil servants.[63]

To combat these problems, a number of policy measures have been discussed or adopted, but few have been sufficiently wide-ranging to change the situation rapidly. Suggested measures in Saudi Arabia to combat low student enrollments in the scientific and technical fields, for example, include limiting enrollment and/or withholding stipends for students in colleges of literature and administration, expanding stipends for students in the scientific and technical fields, or changing hiring policies so that the state would not be obligated to hire graduates in the nontechnical fields for whom demand may be minimal.[64] Indeed, especially in the Gulf States, significant monetary incentives have often been offered to attract and keep indigenous personnel in technical fields. In Saudi Arabia, larger scholarships are offered for study in the new technological institutes. Students in training programs in the new industrial city of Jubail pay no tuition or boarding fees and receive, in addition, free transport, work clothing, and an allowance of about 675 Saudi riyals, or $200 per month.[65]

Similarly, in several countries, greater emphasis has been placed on job placement policies. In Kuwait, strong links between universities and enterprises have been established to facilitate job placement. The Kuwait University science faculty has strong, established links with hospitals, banks, and oil companies, as well as with KISR, where many graduates also work. In both Saudi Arabia and Kuwait, the government is the main employer of nationals. In Saudi Arabia, in fact, graduates work for the government for the same number of years that they studied at the university or else repay the cost of their education (about $20,000).[66]

Finally, Middle Eastern countries have tried to ensure that students who study abroad return home. These efforts have been particularly pronounced in Syria and Iraq, which offer both a series of restrictions on studying and working abroad and incentives to return home once a course of study has been completed. Iraq, for example, restricts study abroad for undergraduates and requires that all physicians and engineers traveling abroad submit a guarantee to return. Iraqis abroad with a master's degree or higher are offered several incentives upon their return, including land, loans to build a home, tax exemptions, transportation costs, travel expenses, and other salary incentives. These policies were apparently successful in Iraq.[67] But in most of the countries under review, including Iraq, despite the wide-ranging financial and other incentives, the preference for nontechnical employment persists.

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[61] See Shaw, *Mobilizing Human Resources*, op. cit., pp. 171-172. One source indicates that in 1980, 50 percent of Arab doctorate holders were not living in Arab countries. See Shamlan Y. Alessa, *The Manpower Problem in Kuwait* (Boston: Kegan Paul International, 1981), pp. 74-75.

[62] For example, public sector employment is guaranteed in a certain wage grade for a certain formal level of education irrespective of specialization. In the public sector, it is therefore not possible to offer higher pay for specializations in short supply, such as certain types of influences, technicians, and professionals. See Heason and Radwan, pp. 217-224.

[63] Sarah Graham Brown, main author, "Mosaic: Home Grown Graduates/Part 4," *The Middle East*, August 1982, p. 1.

[64] "Education Policy Criticized . . . ," op. cit., pp. 44-58.

[65] "Investing in Youth," *Euromoney*, October 1982, p. 31. This is true in most states on the Arabian peninsula. In Bahrain, a technical graduate is paid BS 350 (close to $1,000 per month), on his first job, whereas literature graduates earn only BS 250. See Sarah Graham Brown, "Mosaic: Home Grown Graduates . . . ," op. cit., p. 2.

[66] Brown, op. cit.

[67] Shaw, *Mobilizing Human Resources*, op. cit., p. 180.

Labor Migration Policies

Middle Eastern countries have attempted to regulate migration, but the issue of labor migration is complex, for both the labor-importing and labor-exporting countries. For the labor-importers, the tradeoff is between the immediate need for foreign expertise and the potential negative social or political effects. For the exporters, the tradeoff is between the "brain drain" and the foreign exchange gained from remittances of those working abroad.

Policies concerning labor migration have tended to shift with economic conditions. In the early stages of rapid economic development, when demand for labor was high, both the Saudi and Kuwaiti Governments established open migration policies whereby any person willing to work in their countries was allowed to do so. Especially in the early 1970's, both governments undertook a series of measures to encourage the in-migration of foreign workers, both skilled and unskilled. During the mid-1970's, for example, entry regulations for foreign workers in Saudi Arabia were eased, and income tax on foreigners was abolished altogether; the only deduction from earnings became the 5 percent social welfare tax, or the "zakat."[68] In Kuwait, such incentives included relatively high wages, rent-free homes, and other "perquisites."

By the late 1970's, however, both countries faced growing concern about the political, social, and economic effects of such a rapidly growing expatriate labor force. Consequently, laws and regulations governing the settlement and employment of foreigners were tightened. While both countries still offer incentives for skilled foreign workers, they have more stringently implemented visa and other regulations governing foreigners already in the country.[69] Many foreign personnel reportedly have been laid off, including a reported 10,000 ARAMCO workers, mainly American.[70]

Restrictions on foreign workers in the Gulf States vary widely. In Saudi Arabia, foreign personnel working in the Kingdom are concentrated in foreign enclaves. Kuwait, on the other hand, has encouraged rapid turnover of foreign personnel working on large projects. In both countries, noncitizens are limited in many areas (e.g., landholding, welfare benefits, housing), and naturalization and citizenship are quite limited.[71]

Other labor-importing countries have also established a mixture of incentives and regulations for foreign workers. While Iraq has traditionally placed restrictions on immigration and employment of foreign workers, the drain on manpower resources due to war has forced the Iraqi Government to seek expatriate management and operations teams to staff many industrial projects and health services.[72] Like Saudi Arabia and Kuwait, therefore, Iraq has attempted to offer significant monetary incentives—especially to highly skilled manpower from abroad. In the late 1970's, salary incentives in the Middle East for certain types of skilled personnel were highest in Iraq and Saudi Arabia. (In contracting, for example, a general manager in Iraq earned up to $5,614 per month, as compared to $4,941 in Saudi Arabia, also the upper limit for a chief consulting engineer there.[73]) Thus, particularly for skilled manpower, the labor-importing countries offer financial incentives, while at the same time often restricting the integration of foreign nationals into local society.

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[68] See J. G. Kaikati, "Marketing Practices in Iran vis a vis Saudi Arabia," *Management International Review*, vol. 19, No. 4, 1979, p. 37.

[69] According to this report, the number of visas issued was approximately 772,000, a drop of over 77,000 from the previous year. See "Kingdom Restricts Foreign Work Force," *The Middle East*, vol. 2, No. 4, Mar. 20, 1983, p. 3.

[70] Ibid., p. 3.

[71] See Shaheen Ayubi, "Kuwait's Expatriate Labor Force: Cause for Concern?" paper delivered at the Middle East Studies Association, Philadelphia, Pa., November 1982. A law passed in 1964 stated that only Kuwaitis are entitled to register in the Kuwait Lawyer's Association. See Shamlan Y. Alessa, *The Manpower Problem in Kuwait* (London: Kegan Paul International, 1981), pp. 44-45.

According to Ayubi, op. cit., Article I of the Citizenship Law of 1959, as amended in 1960, 1965, and 1966, states that Kuwaiti nationality is recognized only for people who have been resident in Kuwait before 1920; all others are classified as non-Kuwaiti. Articles 4 and 8 specify that naturalization for non-Kuwaitis of Arab origin requires a 10-year residency before applying; for those of non-Arab origin, the requirement is 15 years. Article 4 also, however, places the limit on the number of foreigners who may be naturalized in any one year at 50. Ayubi, op. cit. See also Jacqueline S. Ismael, *Kuwait: Social Change in Historical Perspective* (Syracuse: Syracuse University Press, 1982), p. 118.

[72] For a discussion of this phenomenon in the health care and industrial sectors, see Jonathan Crusoe, "Foreign Skills Plug Iraq's Manpower Drain," *Middle East Economic Digest*, Jan. 28, 1983, p. 19.

In contrast, especially for Egypt and Algeria, the key issue is emigration. The case of Egypt illustrates the dilemma. While the government of Egypt would like to restrict the outflow of labor of certain types, particularly of Egyptian technicians, labor has also been one of Egypt's main exports, generating much needed foreign exchange. So far, the government has not imposed rigid restrictions on the emigration of skilled personnel. Egyptian planners nevertheless worry that the labor outflow may lead to domestic problems, since the exported skills may be in short supply in Egypt itself.

In Algeria, similar policy debates are taking place. In Algeria the flow of emigrants has been almost as large as that from Egypt, but mainly in the direction of France. During the latter part of the 1970's to 1980's, upwards of 30,000 skilled and unskilled Algerian workers were leaving each year in hopes of finding employment in France. Although this causes concern to Algerian planners, no policy on such emigration has been established.

The implications of the manpower situation for technology transfer are complex. As discussed in chapter 3, it is expected that the demand for foreign labor in the oil-rich countries will be reduced in the near term owing not only to reduced expenditures on large new projects, but also to the entry of many of the Gulf States into a stage of consolidation following the rapid expansion of infrastructure in the past decade. But, while the total numbers of foreign workers can be expected to decline, requirements for highly skilled foreign manpower will certainly remain strong. These factors will continue to draw manpower from the Middle East labor exporting countries, leaving shortages in certain skilled occupational categories at home.

Expansion of scientific and technical education and more attention towards migration policies are helping to address some of these problems. But questions of gearing supply to demand, especially in the scientific and technical fields, and of regulating migration to meet domestic requirements remain major challenges in all of the countries under review and key factors which will continue to affect technology transfer.

TECHNOLOGY TRANSFER AND THE FOREIGN POLICY CONTEXT

Technology transfer choices are often shaped by broader foreign policy concerns, particularly issues of dependence and vulnerability as reflected in economic interactions, and political alliances and conflicts with other countries. This section briefly discusses implications for technology transfer of three types of foreign policy issues: the question of dependence on foreign governments or suppliers, the effect of regional conflicts on economic relations, and regional cooperation in development and technology transfer efforts.

The Question of Dependence on Suppliers

Prior to the 1970's, some Middle Eastern countries relied on a limited number of foreign suppliers for imports of technology, products, and food. In many cases, suppliers were chosen largely on the basis of historical or colonial ties, geographical proximity, and political alliances. Some countries such as Algeria and Iraq traded heavily with the Communist bloc. Others, such as Saudi Arabia and Iran, relied much more on the West.

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[73] See Jonathan Crusoe, "The Cost of Living in the Middle East," *Middle East Economic Digest*, Feb. 4, 1983, p. 15.

The past decade, however, has seen a marked reappraisal of supplier relationships in all of the countries under review, and all have begun to diversify their reliance on foreign suppliers. As analyzed in chapter 3, trading patterns have become increasingly complex, and many countries which traditionally traded extensively with Soviet bloc countries are now relying on Western suppliers. Egypt, prerevolutionary Iran, and Iraq have made a marked shift from trade dominated by Eastern bloc nations, led by the Soviet Union, to trade dominated by the Western industrialized nations led by the United States and West Germany. Prior to the revolution, Iran shifted its imports from the Soviet Union and Great Britain to the United States, France, and Great Britain, with Japan becoming a more important supplier in 1975. For Iraq, the Soviet bloc was the major source of technology until the mid-1970's; beginning in about 1974, however, Iraq shifted to a variety of sources, mainly Japan, West Germany, Great Britain, Italy, and the United States. Similarly, Algeria has recently shown a preference for contracts awarded to EEC countries.

At the same time, there is some evidence that traditionally Western-oriented countries may now consider the Soviet bloc nations as potential suppliers, albeit in a still limited way, and that they have attempted to diversify Western suppliers. Saudi Arabia has pursued policies that leave the close Saudi-American alliance intact but that aim to develop a degree of independence from American influence through diversification among Western suppliers. Consequently, the market share of the United States in Saudi Arabia has declined. Similarly, Egypt since the Camp David Accords and the expansion of U.S. economic assistance has relied increasingly on the United States as a major supplier. Nevertheless, if Egypt is fully reintegrated into the Arab world, diversification of suppliers could occur.[74]

There is little agreement whether diversification of suppliers is a conscious political strategy or simply the result of changes in the economic marketplace. Undoubtedly, elements of both play a role. Some countries, such as Saudi Arabia and Iran, have stressed economic factors in these decisions—i.e., the desire to obtain the best technology on the most favorable terms. In others, such as Iraq, the emphasis has been on avoiding political dependence. Saddam Hussein, for example, has noted the "political essence" of technology transfer and has expressed wariness over the potential loss of freedom of action that could come with heavy dependence on one supplier for technology transfer. Iraq's leader has stated,

> Soviet technology is communist. American technology is American, bourgeois and capitalist. French technology is French, bourgeois and capitalist . . . Even when these states export their technology abroad, they are acting from political motives, as well as others, including transferring their political and social character to the societies to which they are exporting.[75]

Algeria's former President Boumedienne emphasized in the 1970's the importance of economic independence for a country's development. Diversification of trading partners and control over the domestic economy were important themes, as well as Algeria's emphasis on a new world economic order based on equality among developing and developed countries.[76] While it is unclear that these concerns alone would stimulate a conscious diversification of suppliers, they certainly play a role in choices of suppliers. Thus, shifts in choice of suppliers can reflect alignments with the superpowers and other political concerns, as well as a pragmatic choice based on technology quality.

In some instances, diversification of suppliers can lead to more economically advantageous deals for recipients, or possibly expanded political influence over the supplier (see ch. 10).

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[74] In January 1984, Egypt was readmitted to the Organization of the Islamic Conference.

[75] Amir Iskander, *Saddam Hussein: The Fighter, The Thinker and The Man* (Paris: Hachette Realités, 1980), p. 371.

[76] Harold Nelson (ed.), *Area Handbook for Algeria* (Washington, D.C.: American University, 1979), p. 239.

Certainly Middle Eastern countries have had the opportunity to be more selective in technology acquisition, based on their wealth and on the West's reliance on Middle Eastern oil. All of them have gained in capability to set the terms of technology transfer and to choose their suppliers. On the other hand, deliberate diversification of suppliers can also lead to problems in the integration and management of technologies from various suppliers. Regardless of the rationale, the trend toward increasing diversification has certainly stimulated competition among suppliers.

Regional Conflict

Perhaps the most salient example of the direct effect of regional conflict on policies affecting civilian technology transfer stems from the major political conflict in the region—the Arab-Israeli dispute. The effects lie in two main areas: in the desire of Arab countries to catch up with Israel's scientific and technological leadership, and in their desire to affect the political stance of supplier countries through such mechanisms as the boycott of foreign firms or companies trading with Israel.

The stringency with which Middle Eastern countries have enforced the boycott has, however, varied. Saudi Arabia and Kuwait, for example, have been among the more stringent adherents. While the Saudis have shown flexibility in attempting to use language acceptable to the United States and consistent with the boycott, enforcement might be stronger in the future, owing to the use of a new computerized boycott list and the desire of some middle-level Saudis to tighten up enforcement.

The boycott has often been laxly enforced by other countries in the region when it conflicts with other important policy goals. Iraq, for example, has traditionally enforced the boycott rather stringently in a way that reduced contract awards to American corporations. However, since the late 1970's and then the outbreak of war with Iran, Iraq has exhibited increasing flexibility in enforcement, and apparently has often invoked the "national interest" exemption to the Arab League's boycott rules. This has allowed both the Iraqis and foreign companies to sometimes disregard the certification procedure which requires foreign firms to guarantee that goods did not originate in Israel, South Africa, or Hong Kong.

It is often difficult to measure the exact relationship of foreign policy to technology transfer. To cite one example, British Prime Minister Margaret Thatcher prohibited meetings between her government and a high-level Arab League delegation that included a representative of the Palestine Liberation Organization (PLO) in December 1982. Subsequently, Saudi officials hinted that the dispute might jeopardize the $8 billion yearly trade between the two countries.[77] Although it is unclear to what extent this incident actually hurt British trade with Riyadh, threats of trade retaliation can nevertheless be easily invoked by both recipients and suppliers and often substitute for serious actions.

Regional conflict has also had an impact not only on supplier choices, but also, of course, on interactions among countries in the region.[78] Among the more salient examples of this are the isolation of Egypt in the Arab world, and the effects of Khomeini's revolution on the policies of other Middle Eastern states. In the case of the former, for example, the linkage between foreign policy concerns and technology transfer was dramatically clear. President Sadat initiated the infitah, or liberalization policy, in 1973 to promote political and economic cooperation with the West, especially the United States. Later, after Camp David, Arab trade with and capital flows to Egypt fell dramatically. Today, Egyptian trade and foreign relations are improving with the rest of the Arab world, with prospects for increased capital flows to Egypt and joint projects. Trends in technology trade thus have clearly reflected Egypt's political stance.

The revolution in Iran also had a significant effect on technology transfer to that country;

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[77] R. W. Apple, "Saudis Retaliate for Britain's Stand on PLO," *New York Times*, Jan. 5, 1983, p. A8.

[78] Algerian handbook, op. cit.

trade declined, and imports from the United States in particular became reduced to a trickle. Furthermore, the revolution in Iran caused other countries in the region to reexamine their own development policies and raised concerns about the potential adverse political effects of rapid economic development.

Finally, as discussed in chapter 3, regional conflicts have also greatly expanded imports of military technology and equipment. Iraq's purchase of five super Etendard jet warplanes from France, or Saudi Arabia's purchase of AWACs from the United States, have been prominent examples. Many Middle Eastern countries, Israel included, devote a very high proportion of government expenditures to defense.[79]

Regional Cooperation

Despite protracted regional conflict, the Middle Eastern countries have increased efforts to promote regional cooperation in industrial development and technology transfer efforts. Especially in light of the vast differences in resources which exist among the Middle Eastern countries, efforts have been made to share these resources in order to promote more effective regionwide development. An obvious example of regional cooperation is the aid provided by the capital-rich Arab nations to other Islamic nations. Kuwait was the first Arab state to establish a massive assistance program for poorer Arab nations and other Third World countries. Other Gulf States have followed suit, and aid and loans from the capital-rich Middle Eastern countries to those lesser developed occurs on a large scale. As table 98 illustrates, aid from OPEC countries has remained formidable. About 70 percent of Kuwait's assistance has been provided to Arab countries.[80] OPEC countries provided over $63 billion in concessional assistance between 1973 and 1982, most of it in the form of general support assistance offered without conditions, but in recent years levels of assistance have declined.[81]

Table 98.—OPEC Aid in Comparative Perspective (net ODA[a] Disbursements)

	OPEC	DAC[b]	CMEA[c]
$ billion:			
1970	0.4	6.9	1.0
1980	9.1	27.3	2.2
Percent of GNP:			
1970	1.18	0.34	0.14
1980	1.70	0.38	0.14
Percent of total ODA:			
1970	5	83	12
1980	23	71	6

[a] ODA is official development assistance.
[b] DAC countries include most OECD nations.
[c] CMEA countries include the U.S.S.R., Bulgaria, Czechoslavakia, GDR, Hungary, Poland, and Romania.

SOURCE: Organization for Economic Cooperation and Development, *Aid From OPEC Countries* (Paris: OECD, 1983), p. 14.

A similar example of efforts for more regional cooperation is found in "trilateral ventures," which bring together Arab capital, Western technology, and Egyptian manpower. This concept has been discussed in the context of the Euro-Arab Dialogue, as reviewed in chapter 12. Political differences have presented obstacles to implementation of "trilateral ventures," particularly in Egypt.

A number of organizations have been established for regional cooperation in economic development, technology transfer, and other areas. They include the Gulf Cooperation Council, the Arab Fund for Social and Economic Development, the Kuwait Fund, and the Gulf Organization for Industrial Consultancy (GOIC).

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[79] Between 1975-81, for example, Saudi Arabia's defense expenditures rose sharply, with per capita defense spending estimated at about $1,700 in 1979. See U.S. Arms Control and Disarmament Agency, *World Military Expenditures and Arms Transfers, 1971-1980*, March 1983, pp. 53 and 65. Between 1977-80, about 40 percent of total arms exports worldwide went to the Middle East and North Africa. See Patrick Cockburn, "Mideast Military Imports Weather Fall in Oil Price," *Financial Times*, May 9, 1983, p. 5; and Saad Eddin Ibrahim, "Oil, Migration and the New Arab Social Order," in *Rich and Poor States in the Middle East*, Malcolm H. Kerr and El Sayed Yassin (eds.) (Boulder, Colo.: Westview Press, 1982), p. 55.

[80] R. El Mallakh, *Absorptive Capacity of Kuwait* (Lexington, Mass.: Lexington Books, 1981), p. 182.

[81] Financial assistance from Arab development funds reportedly fell to $1.1 billion in the first half of 1983, a 20-percent drop compared to the second half of 1982. However, the proportion of funds going to Arab countries grew from 34 percent of the total in the second half of 1982, to almost one-half (48 percent) of the total in the first half of 1983. See David Hawley, "Arab Aid Commitments Fall Sharply in 1983," *Middle East Economic Digest*, Nov. 18, 1983. See also Larry G. Nowels, "OPEC Aid to the Third World," *Congressional Research Service Review*, vol. 5, No. 3, March 1984.

The Gulf Cooperation Council (GCC), since its creation in the early 1980's, has rapidly expanded economic cooperation in investment, customs, tariff, and in other areas among its six member states: Saudi Arabia, Kuwait, Bahrain, Oman, Qatar, and the UAE. Joint economic projects formulated in the June 1981 Unified Economic Agreement include removing trade barriers, establishing joint stock companies, lifting currency restrictions, and unifying industrial laws and banking and investment procedures. Today, another GCC initiative is to try to coordinate new business activities by Gulf nations. A technology transfer committee was set up in the GCC, which is now also considering a proposal for a "Gulf Center," which would promote technology transfer and technical development. Recently, the GCC established the Gulf Investment Co. (GIC) to act as an investment vehicle, and it is now also attempting to form a common market which its members hope will be operational by the end of the decade.[82]

The Gulf Organization for Industrial Consulting (GOIC) is a regional organization devoted specifically to technology transfer in the industrial sector. Member countries of GOIC have already undertaken a number of projects, such as a fiberglass plant in Saudi Arabia, a steel mill in Bahrain, and have planned aluminum and petrochemical facilities. A feasibility study was initiated for a large petrochemical complex (see ch. 5). Most of the projects are now in the feasibility study stage.

The Arab Fund for Social and Economic Development (AFSED) is one of the most impressive of the regional organizations involved in technology transfer—although it considers technology transfer only one of a number of criteria in evaluating projects for selection. Establishment of a "Technology University" in the Arab world has also been discussed. In contrast to AFSED, the Kuwait Fund is primarily a financing organ, rarely involved in evaluating the projects it funds.[83]

Efforts have also been made to pool or jointly develop manpower resources. The Kuwait Institute for Scientific Research (KISR), for example, has advocated improving knowledge about technology on a regional level so that Arab countries can make better choices and rely more on their own consultants in technology transfer decisions. Kuwait's Social Affairs Assistant Undersecretary, Abdullah Ghalum Husayn, has proposed an Arab employment fund, stating that such a joint venture would lead to the promotion of national manpower resources, particularly in heavily populated regions.

Many efforts at regional cooperation have been promoted by countries emphasizing their common Islamic heritage. The Islamic Development Bank, for example, channels funds to development projects in Islamic nations worldwide. The bank's first project was approved for funding in 1976, and it now has 170 projects, 27 of which involve "technical assistance," although most of this has gone to feasibility studies. Some observers see the bank as a marriage of Islamic principles and modern financing; interest is not charged, but members nonetheless earn a profit. Between 1972 and 1982, the bank provided funding valued at $3 billion; about two-thirds of that went for foreign trade financing for LDCs and about one-third for project financing. Project financing covers a broad range: loans, equity participation, leasing of equipment, profit-sharing, and technical assistance. The bank has financed a few projects solely; typically it teams up with other multinational development organizations or uses other Arab funds for project support. Increasingly, bank projects involve leasing of equipment and technical assistance. While bank officials tend to emphasize the importance of technology transfer, only about 25 percent of the projects are said to focus on technology transfer, largely because many of the projects are in nations that cannot yet absorb advanced technologies.

The Islamic Foundation for Science and Technology is being established as an outgrowth of the Organization of Islamic Countries. The foundation, presently being set up by Ali Kettani, has a governing board comprising the Secretary General of the Organization of Islamic Conference (OIC), Kettani, and 14 scientists nominated by Foreign Ministers of various OIC states. The goals of the foundation are to bring together researchers throughout the Islamic world in order to avoid duplication of effort and to pool common resources. Among current projects are the establishment of a computer network that would allow scientists and technical personnel to have online access to technical information in English, Arabic, and French, and the promotion of advice and consultancy within the foundation. Other plans call for the establishment of a common research framework for member nations, with shared laboratories and facilities to the extent possible.

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[82] See, for example, "GCC Summit: Preview II: Towards a True Unification," *Arab Banking and Finance*, No. 8, October 1983, p. 49; reprinted in "Obstacles Facing Economic Integration in Gulf Discussed," *JPRS: Near East, South Asia*, Dec. 21, 1983, pp. 7-8.

[83] Soliman Demir, *Arab Development Funds in the Middle East* (New York: Pergamon Press, 1978).

Kettani's vision is fundamentally Islamic, and is based on a belief that the weakness of science and technology in the Islamic Middle East is a problem the Islamic countries themselves must overcome. In his view, Western organizations can play a role in this process—but the problem and that role must be defined by the Islamic countries themselves. Since the foundation is only in its infancy, it is impossible at this stage to anticipate how quickly the vision will be fully implemented.

To generalize, efforts have been made to promote regional cooperation in the area of technology transfer, but results remain limited. This is due partly, of course, to the continued volatility and shifting alliances in the Middle Eastern region itself, which add additional incentives for most countries to focus on national development first. Regional cooperation is nonetheless an attractive concept for policymakers in the region, and actions of the Gulf Cooperation Council and other groups suggest that there could be significant movement toward cooperation in certain areas.

CONCLUSION

Two overriding policy challenges related to technology transfer face planners throughout the Islamic Middle East: the challenge of using social, political, and economic resources effectively to promote economic, and especially industrial, development; and the challenge of doing so without unduly increasing dependence on foreign governments or suppliers. To meet these challenges, policymakers in the Middle East continue to debate about the pace and type of development strategy and of technology transfer, and the institutions most effective for meeting these ends. The second challenge is reflected in policies to regulate foreign involvement in technology transfer, both directly—through specific restrictions on the terms of technology transfer, manpower, and foreign investment—and indirectly, through general efforts to diversify suppliers.

All of these issues are complex, and the approaches to solutions have varied. Some Middle Eastern countries such as Saudi Arabia and Kuwait continue to emphasize the transfer of capital-intensive technologies into market-oriented economies. Others, such as Algeria, may be shifting to less heavily capital-intensive technologies, while remaining Socialist. Some countries, such as Iraq, have made extensive efforts to limit foreign involvement. Others, such as Egypt and Saudi Arabia, have encouraged foreign involvement, but with significant regulation. As a number of economic and social indicators of development show, moreover, all of these countries have achieved a measure of success in economic development during the past decade.

Despite these successes, however, barely more than one or two decades have elapsed in most of the countries since development efforts were begun in earnest, and significant challenges remain. For the labor-short countries such as Saudi Arabia and Kuwait, manpower policies remain among the most critical policy areas, as these countries continue to attempt to train indigenous workers in technical skills and scientific and engineering professions. In these countries, the manpower problem may be said to have been temporarily solved by policies of importing laborers and limiting and circumscribing their activities, while simultaneously encouraging the continued training of indigenous personnel in technical skills. But incentives for indigenous populations to enter technical occupations are still limited, and this remains a decided constraint on the successful implementation of policies to develop indigenous capabilities.

For those countries with more varied resources but limited financial reserves, such as Egypt and Algeria, issues of administrative reform, as well as financing, remain paramount. Among countries in the Islamic Middle East, Egypt presently has a rich human resource base, but its administrative and political context often produces inefficiency. The key challenge for Egypt remains in fully utilizing its human resources in light of political and administrative problems which act as constraints. Rapid reform may stimulate political opposition, but inaction may also produce negative consequences for the leadership. A key challenge for Egypt is to weave a delicate path between these two courses. For Algeria as well, issues of administration remain a critical policy area, as does the need to reverse the "brain drain" of skilled personnel. Policies to deal directly with these issues are only beginning to be formulated.

Both Iraq and Iran had a relatively well developed infrastructural and industrial base before the outbreak of war between them. A key issue for both, therefore, is to compensate for the diminution of resources—financial, human, and otherwise—from the continuation of the war effort. New resource demands may lead to substantial differences in the way technology transfer may be conducted. In Iraq, capital constraints on financing of technology transfer may become serious problems for the ruling regime. But for both countries, technology transfer policies depend on the course of the war. Today, the Islamic Iranian regime remains outwardly hostile toward Western technology. But increasing overtures to the West and the restarting of several projects begun before the revolution suggest prospects for Iranian reintegration into global trade.

For the Islamic Middle East as a whole, regional cooperation in technology transfer and industrialization continues to be emphasized. Indeed, economic integration would benefit most Middle Eastern countries, given the large resource imbalances among them. The persistence of regional conflict, however, remains a serious impediment to these efforts. The challenge for all Middle Eastern countries is to create the conditions for greater cooperation in the midst of conflict and to accommodate far-reaching economic and technological changes while keeping the essential core of Islamic tradition vital and relevant.

In short, technology transfer policies are in practice geared to the requirements of specific projects and sector development programs, despite efforts to establish a comprehensive framework. No nation can afford to purchase all available technologies, and the capacity to absorb advanced technologies is limited by a number of factors, especially shortages of technical manpower. Thus, Middle Eastern countries continue to be faced with tradeoffs in selecting technology purchases and suppliers, in formulating development strategies and goals, and in developing an indigenous capability to operate and maintain technology effectively while simultaneously seeking independence from foreign influence. The challenges facing all of the Islamic developing countries in the Middle East therefore, remain formidable, and a large role for foreign assistance will be required for development aims to be attained. Foreign suppliers, for their part, must be sensitive to the demand of recipient countries to sustain their own independence and sovereignty over development and technological decisions and to the economic and political effects of these choices in the Middle East as a whole.

Table 11A-1.—Summary Recommendations of Major Policy Studies on Science and Technology in Egypt, 1972-80

Study title	Date	Sponsoring agency/organization	Major observations/recommendations
Arab Republic of Egypt: Current Problems in Science and Technology (22 pp.)	1972	UNESCO	1. There is *a lack of integrated science/technology (S/T) policy* at decisionmaking and executive levels 2. Recommend formation of inter-ministerial committee for research and development with power to examine and approve all Government of Egypt (GOE) plans and budgets 3. Must solve problems of formulating a strategy for including the preparation of nationwide inventory of S/T resources 4. There is a lack of updated S/T information especially modern books and journals. GOE must finance and encourage professional travel
Arab Republic of Egypt: Science Policy-Making (22 pp.)	1974	UNESCO	1. Links between four major levels (researchers, users, executive, ministerial) of S/T policy formulation need to be strengthened. Create joint inter-ministerial committee for science planning 2. The proposed committee would formulate long-range (20 years) role of S/T in Egypt 3. The autonomy of the Academy of Scientific Research and Technology (ASRT)[a] should be preserved with strong ministerial support. The ASRT should organize a special unit on science policy 4. Establish a National Center for Information on Research Potential and Performance to generate data for planning and budgeting and evaluation of research activities 5. Revise present system of employing research workers to provide greater incentives
Science and Technology Policy, Research Management and Planning in the Arab Republic of Egypt (symposium)	1975	ASRT National Academy of Science (U.S.) National Science Foundation (U.S.) National Research Council (U.S.)	1. Egypt *lacks a formally enunciated science policy although* there appears to be an *implicit* policy 2. The ASRT has an important coordinating and guiding role. It manages a sizable research effort that requires considerable restructuring and redirection 3. R&D groups in Egypt must be effectively involved in the process of technology transfer 4. Effective intraorganizational linkages and communication are lacking 5. Training programs should be developed to improve the management of R&D programs 6. Research staff should have appropriate financial incentives 7. Improved equipment, libraries, and support facilities are necessary for high-quality research effort 8. A national science plan, including specific objectives for applied research, should be formulated in conjunction with a clear and concise national economic and social development plan 9. Effective technology transfer at minimum cost requires revision of national legislation

Table 11A-1.—Summary Recommendations of Major Policy Studies on Science and Technology in Egypt, 1972-80 (continued)

Study title	Date	Sponsoring agency/organization	Major observations/recommendations
National Science and Technology Policy in Egypt (60 pp.)	1975	UNESCO Arab League, Cultural and Scientific Organization	1. There is *no comprehensive national science and technology plan* or consensus as to national problems and priorities. The ASRT has an important role in facilitating articulation of these 2. It is difficult to get scientific personnel to commit to group/national research objectives *if* these are not consistent with their individual research interests 3. The scientific community is isolated from potential users of technology
Egyptian Development and the Potential Role of Science and Technology (268 pp.)	1976	USAID (University of North Carolina was the prime contractor)	1. There is insufficient interaction between researchers and end-users of research findings 2. Development planning by government agencies, technology planning by public sector enterprises, and science planning by the ASRT and its related council is too compartmentalized. There is no communication between these respective planning units, between planners and project managers, and between planners, managers, and end-users 3. ASRT effectiveness must be improved to give it a stronger coordinative hand
A National Strategy of Scientific Research	1977	ASRT	1. Solution to technology problems must be found with emphasis on resolving those where the expectation of success is high 2. Any national scientific research plan must focus on concepts and issues of strategy in: the transfer and adaptation of technology; food security; natural resources; housing; health; enery; scientific and technological information; management development; communications linkages; and the Open Door policy
Transfer and Development of Technology in Egypt (32 pp.)	1980	UNCTAD	1. Only recently (circa 1978) has Egypt paid attention to the import of technologies in its official policies 2. There *needs to be an explicit policy for dealing with foreign technology* 3. There are a number of critical gaps in the present GOE arrangement regarding technology transfer and development, both at the policy level and in the coordination of the various institutions involved 4. A National Center for the Transfer and Development of Technology should be established and affiliated with the ASRT

[a] This organization, formed in 1971, replaced the Ministry of Scientific Research as the unit responsible for S/T planning and coordination.

NOTE: The Near East Bureau of AID was conducting an assessment of S/T programs in 1984.

SOURCE: Compiled for the Office of Technology Assessment.

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Policies of Other Supplier Countries

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CHAPTER 12

Policies of Other Supplier Countries

INTRODUCTION

The governments of other supplier nations have developed different approaches to technology trade and transfer, but their policies have been generally viewed by U.S. observers as comparatively supportive of technology exports by domestic firms. The policies of other supplier governments are important, because debates about U.S. policies often center on questions of what other governments do, and how important their policies are in affecting the pattern of technology trade.

The purpose of this chapter is to analyze variation in the policies of both Western and Soviet bloc nations, and to evaluate the significance of those policies for technology trade with the Middle East. First, as background to the treatment of specific policies, patterns of economic interaction between various suppliers and Middle East nations during the past decade are examined, and explanations for observed patterns considered. Government policies affecting technology transfer to the Middle East (including foreign, commercial and development assistance policies) are then discussed and variation assessed. Finally the chapter evaluates the effects of these policies on the extent and nature of technology trade with the Middle East. This analysis provides a foundation for assessment of U.S. policies in chapter 13.

The chapter deals with two sets of supplier nations: West European and Asian supplier countries in Part I and Soviet bloc supplier countries in Part II. In addition to the United States, the most important nations supplying advanced civilian technologies to the Middle East are advanced industrial nations in Western Europe and Japan. Developing nations such as South Korea have expanded their role in Middle East markets, primarily in labor-intensive construction projects. Firms from Western Europe and Japan can, in most cases, supply advanced civilian technology comparable to that of the United States. In Great Britain and France governments have been noticeably involved in Middle East politics and diplomacy, but in all of these industrial countries public and private sectors have cooperated through a broad range of institutions to promote technology trade and transfer.

While in no case are foreign policy positions simply derivative of economic and energy interests in the Middle East, many supplier countries have formulated foreign policy by emphasizing economic interests, and some have concluded that enhancing their economic welfare may bring political benefits as well. Taking different approaches, most have developed policies more favorable to technology trade with the Middle East than those of the United States, as outlined in chapter 13.

The Soviet Bloc countries, in contast, conduct comparatively small amounts of commercial technology trade with the Middle East and therefore do not figure as prominently as competitors in the sectors examined by OTA. For the Soviet Union, military assistance has been the most important channel for interactions with Middle East nations, but interest in expanding commercial trade has grown in recent years. Some East European countries have been more active in civilian trade than has the Soviet Union, but they still provide only a comparatively small share of total exports to the region and their sales have been concentrated in a few sectors such as heavy machinery. Despite the comparatively small role that Soviet bloc nations play in commercial technology trade with the Middle East, the region has been important to them as a focus of military assistance and their largest noncommunist developing-country export market.

The analysis that follows concludes that governments play an important role in setting the context for technology trade through development of overall foreign policies toward the region. The context for economic interaction is thus set by political and historical factors. French exports flow primarily to Egypt and Algeria (the latter a former colony), while British exports go to the Gulf States, including the United Arab Emirates (UAE), Qatar and Oman (an area under British rule in years past). Japan's technology trade relationship is less concentrated, a trend reflecting the fact that Japan is a relative newcomer to the region. Soviet bloc trade is most notable with Iraq, Iran, Syria, and Algeria. Former colonial ties, oil import requirements, and political alliances have been important factors influencing the volume and nature of technology trade between the various supplier and recipient countries.

Generally speaking, those countries playing central political and diplomatic roles in the Middle East (Great Britain and the Soviet Union) have placed less stress on commercial promotion of technology trade than countries such as Japan, West Germany, Hungary and Romania which have not taken such leading roles. Only France has attempted to combine a high-profile political role with government-led trade promotion. This analysis indicates that the Western countries eschewing leading political roles have in some cases been able to establish extensive trading relations with a politically diverse group of Middle Eastern countries.

Foreign policies set the context for technology trade, but all of the Western nations have a wide range of specific policies designed to promote technology trade by putting buyers and sellers in contact, by financing exports, through development assistance and some multinational efforts such as the Euro-Arab dialog. These specific policies and programs support expansion of technology trade but certainly do not determine its nature or volume. It is quite striking, however, that in Western Europe and Japan government and business commonly end up on the same side, promoting technology trade.

I: WEST EUROPEAN AND ASIAN SUPPLIER COUNTRIES

During the last decade economic involvement of West European and Asian countries in the Middle East has increased rapidly. By the end of the decade, the area had become a key trading region for them. This growing economic interaction is illustrated by the fact that the Middle East replaced the United States as the largest market for exports from the European Community (EC). In 1980, Japan became the supplier country with the largest volume of exports to the Middle East. Newly industrializing nations such as South Korea, which are heavily dependent on petroleum imports from the region, have also rapidly expanded exports in less advanced technology products and services to the Middle East. In 1981, more than 15 percent of South Korea's exports went to the Middle East.

These countries were stimulated to increase such trade in order to cover their rising energy imports from the Middle East. Generally speaking, despite the fact that they have attempted to reduce their dependence on oil imported from the Middle East, they all remain heavily dependent on those hydrocarbon imports. The Middle East is Japan's energy lifeline—more than 64 percent of Japan's crude oil and refined product imports came from the region in 1982. Similarly, the Western Europe imported more than 60 percent of its oil and refined products from the Middle East in the same year. Middle East demand for technology trade and transfer grew along with the energy requirements of the Western supplier nations.

TRENDS IN ECONOMIC INTERACTION

Table 99 shows that the Middle East market has become increasingly important for Western supplier nations, in terms of both exports and imports. Imports of these nations from the Middle East are overwhelmingly oil-related. Some, such as Japan, have had a continuing balance of payments deficit with the Middle East, due to large oil and gas imports which have far outstripped rising exports. Were it not for Japan's extreme dependence on Middle East oil, the country's overall trade balance throughout the world would have been approximately three times as favorable as it was in 1983.

Another factor which distinguishes the economic interaction of the supplier countries one from another is the extent of their arms sales in the region. Japan is unique among these supplier countries in its policy of not selling arms. West Germany has not officially embraced arms sales in its interactions with the region, but does export armaments to countries in the Middle East. France ranks a distant third to the U.S.S.R. and the United States in arms sales to the region. The United Kingdom ranks a close fourth.[1] Among the non-U.S. Western suppliers, France has capitalized on arms sales to the Middle East. French exports of arms to the Middle East quadrupled between 1974 and 1980, and of $4.8 billion in French military sales worldwide in 1981, 72 percent went there. Therefore, for France and to a lesser extent the United Kingdom, arms sales in the Middle East are a significant part of their economic interactions with the region.

Table 99.—Exports and Imports to Middle East as a Percentage of Total Exports and Imports for Western Nations, 1973 and 1981

	Exports		Imports	
	1973	1981	1973	1981
Japan	4	11	12	30
France	5	9	9	17
West Germany	3	8	6	9
Italy	5	17	12	22
United Kingdom	4	9	7	7
United States	3	8	2	6

NOTE: Middle East includes Saudi Arabia, Iran, Algeria, Egypt, Iraq, Kuwait, Libya, UAE, Syria, Lebanon, Jordan Qatar, Oman, North Yemen, South Yemen.

SOURCES: United Nations, *Trade With Industrial Countries*; International Monetary Fund, *Direction of Trade Yearbook*.

Japanese economic interaction is further marked by large plant exports, averaging around $3 billion annually to the Middle East in recent years.[2] This represents roughly one-quarter to one-third of Japan's total plant exports worldwide in recent years. Japan also exports large volumes of chemical and heavy industrial products. Up until the oil crisis of 1973-74, Japan's direct investment in the Middle East was severely limited. By 1981 the total proportion of cumulative Japanese investment in the region, much of it in resource-related investments such as petrochemical operations, had risen to 6.2 percent of total foreign investments.[3] Such investments, however, are minuscule in comparison to the total volume of Japanese exports to the Middle East—$170 million compared with $14 billion per annum in recent years.

In Japan's approach to Middle East markets, the major trading companies have figured prominently. Preferring to establish their own outposts, various Japanese trading companies have concentrated on specific country markets—Mitsui in Iran, Marubeni and Mitsubishi in Saudi Arabia, Nissho Iawai in Kuwait. The trading companies with their diversified trade portfolios are major conduits for economic interaction--one selling TVs to Egypt, water and crude oil pipe to Iraq and Saudi Arabia, construction machinery to Iraq, Iran and Turkey.[4] Japan's operations in the Middle East are thus quite varied, including direct investment and joint ventures, but featuring sales of equipment, products and most particularly plants.

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[1] See Anthony H. Cordesman, *Jordanian Arms and the Middle East Balance* (Washington, D.C.: Middle East Institute, 1983), pp. 150-151.

[2] Plant exports combine capital equipment, technology, construction and managerial services in one package. In 1982, for example, 141 Japanese plant exports to the Middle East valued at $3.1 billion occurred. These exports represented almost one-quarter of all Japanese plant exports worldwide. See *Tsusansho Koho* (MITI Gazetta), June 23, 1983.

[3] Japanese Ministry of Finance data show that the bulk of these investments were in real estate, branch offices, and manufacturing. The largest part of the manufacturing investments are in the petrochemical industry and oil-related investments.

In contrast, South Korea's forte has been construction services. In 1981, South Korea ranked second in the world in the value of construction contracts won by its firms. Almost the entire number (93 percent) of the $13.7 billion worth were won in the Middle East. To illustrate their importance, these contracts totalled four times the nation's exports to the region in that year, and about equalled Japan's exports to the Middle East. South Korea's economic interaction with the region—like that of the Philippines, Pakistan, and Thailand—has featured construction services involving the temporary "export" of Korean labor.

Most other developing countries, such as Taiwan, export comparatively small volumes of light manufactured goods, including clothing, electrical appliances and light manufactures. Taiwanese exports to the Middle East in 1981 totalled $1.2 billion.

Newly industrializing nations export light manufactures and construction services to Middle East nations, and have not been major exporters of advanced technologies and equipment. These nations thus play important roles in large Middle East development projects, but as a rule do not compete directly in advanced technology trade. This situation is changing, as indicated by the growing awards of Saudi Arabian hospital design (and construction) contracts to South Korean firms.

Photo credit: Middle East Economic Dige

Korean construction worker in the Gulf

The proximity of Europe to the Middle East and the dependence of many West European nations on petroleum imports have served to stimulate economic interaction. West European exports have been concentrated in electrical equipment and machinery, and this pattern is particularly noticeable for West Germany and Italy. French telecommunications exports have surpassed the nation's heavy machinery exports to Egypt and Iraq, and British telecommunications exports have been particularly strong in Egypt, Iraq and

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[4] C. Itoh's include these varied operations, in addition to a number of others. See *Middle East Economic Digest*, December 1982, p. 23.

Saudi Arabia. France and Italy have been perhaps most willing to strike technology for oil deals with oil-producing nations such as Iraq. Bilateral government-to-government oil purchases have become increasingly important, and associated with them have been sales of advanced technologies, including nuclear technology transfers.[5]

All of the West European nations have favored turnkey plant sales, rather than direct investment. Britain has been less successful in overall exports; however, there are estimated to be 30,000 British consultants working in the lower Gulf region alone, indicating British strength in technical services. The French and the West Germans, with their traditions of technical education, have been sensitive to training needs of Middle East nations. Each of the West European nations thus specializes in particular types of technology trade with specific Middle East countries, and as a rule their joint-venture equity participation in the region is quite limited.

Still another distinguishing feature of economic interaction of supplier states is their economic assistance to Middle East nations. In a number of cases, government-supported economic assistance projects involve government and private sector working together. In terms of the total value of official development assistance (ODA), all of these nations rank below the United States, which provided $5.7 billion worldwide in 1981, compared with $4.1 billion for France, $3.2 billion for West Germany and Japan, and $2.1 billion for the United Kingdom. Measuring ODA as a share of gross national product (GNP), France (.73 percent) ranks well ahead of the United States (.20 percent), followed by West Germany (.47 percent) and Britain (.44 percent), and Japan (.28 percent).

No Western nation directs to the Middle East more ODA proportionally than does the United States, which provided Egypt and Israel together with about 33 percent of all American ODA worldwide during the same year. The total bilateral ODA contribution of West European nations and Japan to certain Middle East nations has been considerable, however. In 1981, for example, Egypt received $2.4 billion in ODA, of which the United States provided 44 percent of the total and the other major Western suppliers together almost 35 percent. See table 100. To cite another example, Algeria received $80 million in technical cooperation grants during 1981, of which the European Economic Community (EEC) contributed more than $70 million, with the largest contribution made by the Federal Republic.[6] Historical and colonial ties color French assistance to Middle East nations, particularly Algeria.

To summarize, these countries display significant variation in patterns of economic interaction with the Middle East. The region makes up a large share of some of these nations' exports—in Japan and Italy, exports to the region made up about 11 and 17 percent respectively of the total worldwide in 1981. With the exception of Great Britain, these nations are heavily dependent on oil imports from the Middle East.

France and the United Kingdom stand out in their emphasis on arms sales. Turnkey plant and equipment and product sales have been the dominant modes of civilian technology trade, with the British active in consultancies and the Germans and French in technical training and assistance. France is the largest donor of economic assistance and its program is centered in former colonies in the region.

For all of these nations, economic interaction rose sharply during the last decade, and for most of them (with Japan and West Germany being the exceptions) interactions were concentrated in a few nations important for political reasons, as shown in table 101. Indeed, for even those nations with virtually no previous

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[5] See David A. Deese and Linda B. Miller, "Western Europe," in *Energy and Security*, David A. Deese and Joseph S. Nye (eds.) (Cambridge, Mass.: Ballinger, 1981). The authors note that, despite the fact that France has most aggressively pursued bilateral deals, the French have reaped no obvious advantages in terms of assured oil supplies. See p. 205.

[6] Data from Organization for Economic Cooperation and Development (OECD), *Geographical Distribution of Financial Flows to Developing Countries 1978-81* (Paris: OECD, 1983).

Table 100.—Egypt: Industrial Country Aid and Market Shares, 1981

	Total imports to Egypt		Total official receipts for ODA (AID)[a]	
	Million U.S. dollars	Exporter country share as percent of total industrial country exports to Egypt	Million U.S. dollars	Donor country share as percent of total bilateral industrial country ODA
United States	1,737	29 %	913	44%
Japan	38	0.6	76	4
France	114	2	391	18
West Germany	883	14	77	4
Italy	651	10	172	8
United Kingdom	433	7	12	15
Industrial country total	6,033		2,071	
Total world	8,782		2,404	

[a] Includes Official Development Assistance, as well as bilateral concessional transactions such as export credits

SOURCE: For total imports, International Monetary Fund, *Direction of Trade Statistics*, 1983; for aid, OECD, *Geographical Distribution of Financial Flows to Developing Countries*, 1982

Table 101.—Significant Bilateral Relations in Civilian Technology Trade, Late 1970's

	United States	Japan	France	West Germany	Italy	United Kingdom	U.S.S.R.	Eastern Bloc
Algeria			**(−)	*	(+)		###	
Egypt	**(+)							
Iran	*(−)	*		*			###	###
Iraq		*		*			*	###
Kuwait	*	*(+)						
Saudi Arabia	**	*(+)						
Libya				*	**			
UAE		**				*		
Qatar		**				*		
Oman		*				**		
Syria			*	*	*		###	

(+) or (−) increasing or decreasing

*Strong presence

**Preeminent market share (25 percent + of total imports to recipient country)

#Significant presence for Soviet bloc, but much smaller than any Western presence

Based on total imports from industrial countries, for United States, France, West Germany, Italy, or United Kingdom, 1978 International Monetary Fund, *Direction of Trade Yearbook*, Various Volumes. U.S.S.R. and Eastern Europe, based on Joint Congressional Economic Committee, *The Political Economy of the Middle East, 1973-78* (Washington, D.C.: U.S. Government Printing Office, 1980), p. 515

SOURCE: Office of Technology Assessment

ties to the Middle East, during the 1970's the region became a major factor in economic and energy planning. Chapter 4 presents a detailed analysis of supplier shares in technology trade during the past decade.

FOREIGN POLICY CONTEXTS

National approaches to technology trade distinguish the major Western supplier countries one from another. Each country's strategy is influenced importantly by traditions of government-business relations, as well as by historical ties with the Middle East, energy requirements and geographical proximity. Technology trade takes place within a broader foreign policy context, the prime elements of which are examined briefly below.

While there is considerable variation in the policy perspectives and actions taken by each of the major Western suppliers, two important themes stand out. First, they have at times been reluctant to follow the U.S. lead in international energy policy and diplomacy during the last decade, reflecting their comparatively high dependence on imported oil and a perceived shift away from the United States as preeminent alliance leader. Secondly, while there are notable differences in the roles that governments play, in all of these nations business and government consistently end up on the same side—favoring promotion of technology trade with the region.

Regardless of whether one concludes that this policy emphasis results from a concentration on economic interests at the expense of political principles, or whether one argues that these two sets of interests are simply perceived as more congruent than is the case in the United States, the striking fact is that many of these nations have included calculations of their economic interest centrally in the development of their foreign policies. After a brief review of the general foreign policy context, the chapter reviews trade promotion and financial policies, paying special attention to the institutional mechanisms supporting government-business policy coordination.

Geography and history figure in the foreign policy perspectives of various supplier nations. Europe and the Middle East are natural economic partners, given their geographical proximity and accessibility through the Mediterranean seaway. Their colonial association has given Europeans experience with Middle Eastern customs, habits, and language. Japan and other Asian nations, in contrast, are situated thousands of miles away and lack a history of colonial, political or cultural ties. It is not an exaggeration to say that up until the time of the 1973 oil crisis many Japanese knew little about the Middle East.

Among the major Western supplier countries, France had the most extensive colonial involvements in the Middle East—in Tunisia, Morocco, and Algeria (where a long independence struggle had deleterious effects on French relations with the Arab world), and in Syria, where the French relinquished League of Nations mandates in the mid-1940's. Under De Gaulle, who was intent to return France to great power status in the 1960's independent of either the United States or the Soviet Union, the French actively sought to create a third force in world politics emphasizing nationalism—a resonant theme for many newly independent states.

De Gaulle, and then his successors Pompidou and Giscard D'Estaing, courted the Arabs beginning with a condemnation of Israeli action after the June war in 1967. Even for French leaders such as Pompidou with a less grandiose vision of the French place in international affairs, the nation was viewed as a regional power in the Middle East, which was generally construed to include the Mediterranean rim. In addition, French policy reflected a desire to balance American policy in the Middle East, which was seen as strongly weighted toward Israel, with Western representation in the Arab states. This desire for representation also explains France's greater willingness to cooperate with Arab states in the military sphere, exemplified by sales of Mirage jets to Libya in 1969 and nuclear cooperation with Iraq.

These larger foreign policy concerns dovetailed with evolving French economic and energy interests in the region. Like Japan, France imports a large percentage of its oil. In response to the oil crisis, French leaders moved to strike oil-for-technology deals with Arab nations, making export promotion (by firms many of which are nationalized) a top priority.[7] High-level officials visited Middle East nations looking to secure energy supplies and expand sales. From the French perspective, political and commercial relations go hand in hand; as former Foreign Trade Minister Michel Jobert put it, "there is no gap between diplomacy and commercial relations."[8] In Algeria, American, German, and Japanese exports have all surpassed French, illustrating the maxim that when French political relations deteriorate commerical relations are likely to decline as well.

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[7] Lawrence G. Franko and Sherry Stephenson, "French Export Behavior in Third World Markets," in Center for Strategic and International Studies, *World Trade Competition: Western Countries in Third World Markets* (New York: Praeger, 1981), pp. 183-87. The continuing importance to the French economy of exports to the Third World is highlighted in a government study by Yves Berthelot and Jacques De Bandt, *impact des relations avec le Tiers Monde sur l'economie Francaise* (Paris: La documentation Francaise, 1982), report and supporting papers.

[8] "France and the Middle East," *Middle East Economic Digest*, May 1982, p. 6.

There was considerable speculation that Mitterrand's election would bring a shift in French policy toward Israel. French policy, however, remains firmly oriented in a state-led program of export promotion directed at the other countries in the region.[9] France is the West European nation which has taken the most energetic approach to opening relations with the Arab world during the last decade, and these efforts have been increasingly informed by an appreciation of the many trade, cultural and other opportunities rather than a simple oil-for-technology calculus.

Like the French, the Italians have aggressively expanded exports to the Middle East to cover oil imports. By virtue of its geography, Italy is in an excellent position to expand such trade. It has established a particularly strong trade relationship with Libya, followed by Saudi Arabia, Iraq, and Iran before the revolution. Probably more than any other Western country, Italy has cultivated the notion of interdependence between itself and the Middle East. Italian state or state-owned companies are central negotiators of commercial deals with Arab countries, in an approach that resembles that of the French.

Britain's relationship with the Middle East reflects that nation's role as the most important former peacekeeping power in the Gulf. Britain held key oil concessions in the former Ottoman Empire from the early 20th century, and was preeminent in securing oil concessions prior to World War II.[10] The British presence was felt particularly in the Gulf States, but in Egypt as well, during the colonial era. British leaders such as Foreign Secretary Arthur Balfour articulated sympathy with the "establishment in Palestine of a national home for the Jewish people"[11] and Britain eventually became the mandatory power over Palestine until the establishment of the state of Israel.

While the legacy of Britain's colonial past is reflected in a largely pro-Arab Foreign Office, British policies have been motivated more than any other supplier nation by links to the United States.[12] Unique among Western nations in not relying on Arab oil, Britain has not been a major civilian technology exporter to the region. Commercial exports to the Middle East by British firms have consistently been lower than those of any of the other major suppliers. At the political level, Britain has denounced Israel's settlement policy, but has also refused to recognize the Palestine Liberation Organization (PLO).[13] While the British Government facilitates technology trade with the Middle East, it has generally not taken the high-profile initiating role that the French Government has taken.

At the other end of the spectrum in terms of historical and political ties to the Middle East are West Germany, and most especially Japan. West Germany is a relative newcomer to commercial activities in the Middle East. While some German companies have had long and uncertain associations with the Middle East that stretch back to the beginning of the century, Germany had no colonial involvement on which to build postwar economic relations. The Federal Republic, furthermore, carried a debt from the World War II era that has made the formulation of policy toward the Middle East difficult.

Bonn has consistently supported the State of Israel's right to exist, a stance which in the 1960's prompted 10 Arab States to sever diplomatic relations. During the postwar period, West German leaders were most intent on economic growth and were generally tentative about asserting German interests on the world stage. In fact, some have argued that West Germany's preoccupation with the question of reunification with East Germany precluded any effective role in North-South issues.[14]

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[9] The former French Minister of Research and Industry, Jean-Pierre Chevenement, noted the importance of exports, particularly technology exports to the Middle East, and targeted sales to Egypt, Iraq, Algeria and Morocco. Interview at the Ministry, January 1983.

[10] Louis Turner, *Oil Companies in the International System* (London: Royal Institute of International Affairs, 1978), ch. 2.

[11] The Balfour Declaration issued in 1917 stated this sentiment.

[12] Dominique Moisi, "Europe and the Middle East," in *The Middle East and the Western Alliance*, Steven L. Spiegel (ed.) (London: George Allen and Unwin, 1982), p. 23.

[13] The visit to Saudi Arabia by British Secretary of State for Foreign Affairs Frances Pym was cancelled abruptly in 1983 due to Prime Minister Thatcher's views on the PLO issue.

Where the French have been quick to stress the links and connections between politics and economics, between diplomacy and commercial relations, the West Germans have tried to separate the two—to minimize, neutralize and diffuse the political issues and let commercial deals be struck on their economic merits. In the years since 1974, Germany's continuing dependence on Middle East oil and the importance of Arab markets have resulted in efforts to maintain good relations with Arab leaders.

During the last decade West Germany has become more open to the Arab world. The SPD-FDP government[15] of Willy Brandt supported UN resolution 242 and endorsed European Community positions calling for the Israeli withdrawal from occupied territories. New diplomatic initiatives brought normalization of relations with all Arab states by 1974. More than any other of these major supplier countries, West Germany has given the lead in technology trade to private-sector firms, and the result has been extremely successful commercial relations with Middle Eastern countries noticeably devoid of special relationships.

Japan, even more than the Federal Republic of Germany (FRG), had no colonial and few political or cultural ties with the Middle East up until quite recently. The critical factor for Japan has been growing dependence on Middle East oil. In the wake of the oil crisis of 1973, Japan's Vice Premier and Minister of International Trade and Industry visited the Middle East with promises of massive economic and technical cooperation in return for oil supplies. After considerable discussion within the government, Japan announced its support for the Arab position of Palestinian self-determination and Israeli withdrawal from occupied territories.

Japan's commercial involvement in the Middle East has grown rapidly; by the end of the decade Japan replaced the United States as the number one exporter to the region. Like West Germany, Japan has eschewed "special relationships," and sought to emphasize economic interactions while avoiding in particular any military involvements.

Japan's relations with the Arab world, like West Germany's, have expanded during the last decade. During the 1976 UN Security Council session, Japanese Ambassador Saito proposed a direct dialog between the PLO and Israel. In 1980 both Anwar Sadat and Yassir Arafat were invited to Tokyo, and the PLO leader met with former Foreign Minister Toshio Kimura. Japan was also criticized by high U.S. officials for its policy of buying oil from Iran during the 1979 crisis.

Clearly, Japan's oil dependency has stimulated economic interaction with the Middle East. Japan's export-oriented business sector has had a natural interest in opening the Middle East market. The Government of Japan has taken more of a leading role than the West German in backing up "national projects" in the Middle East involving investments in petrochemical and other industrial projects.

In July 1983, Japanese Foreign Minister Shintaro Abe visited Iran and Iraq in an attempt to persuade them to end their prolonged war. This uncharacteristic departure from Japan's normal reluctance to get involved in high-level diplomacy was inspired by Japan's growing trade with Iran and the desire of Japanese leaders to take on a larger political role.[16] Thus, in recent years Japan has begun to address political as well as economic issues in its foreign policy toward the region.

Newly industrializing countries such as South Korea and Taiwan have been much less involved than the major suppliers in either commercial technology trade or high politics. In the case of Taiwan, relative isolation is heightened by the fact that many Middle East nations view the People's Republic of China as potentially far more important economically in the long term. In addition, Taiwan's ties to Israel, while somewhat limited and often covert, are not insignificant.[17]

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[14] See Roger Morgan, "West Germany's Foreign Policy Agenda," *The Washington Papers*, No. 54 (Beverly Hills, Calif.: Sage, 1978), pp. 58-69.

[15] The Social Democratic and Free Democratic Parties formed a coalition government.

[16] See Tracey Dahlby, "Tokyo's Envoy to Ask End of Iran—Iraq War," *Washington Post*, July 29, 1983.

South Korea has, like Japan, more actively nurtured ties with Arab states in the last decade. In 1979, President Choi virtually recognized the PLO, and in 1980 South Korea doubled its donation to the Palestinian Refugee Fund. Other developing nations—Pakistan, Thailand, India, in particular—have become major exporters of workers and some light manufactures to the region. The newly industrializing nations have thus been important suppliers of unskilled labor as well as technicians needed for large development projects.

Colonial ties, geographical proximity and energy requirements thus influence the foreign policy context within which technology trade occurs between each of the suppliers and the Middle East. Notable, however, has been a growing orientation toward the Arab states which at times has been coupled with a reluctance to closely follow the U.S. lead in energy and political matters. In all cases, the dominant theme has been to promote economic relations with the Middle East but, as analyzed in the next sections, the roles that governments have played vary distinctly.

INSTITUTIONAL MECHANISMS FOR PROMOTING TECHNOLOGY TRADE

None of the supplier countries have official public policies governing technology transfer to developing countries, or to the Middle East specifically. Nevertheless, all of them have employed a range of institutions in the public and private sectors to assist technology trade and transfer. Promotional activities in France have been coordinated through government ministries and departments which have attempted to link economic planning targets with associated export opportunities. In contrast, the West German Government has given the lead to private sector firms, but various ministries (Economics, Research and Technology, and Economic Cooperation) have supported private sector efforts—as have the financial institutions.

Japan and Britain lie somewhere in between France and West Germany in terms of the role played specifically by the government; in both cases quasi-public organizations have helped to coordinate promotional efforts. In Japan, however, the private sector firms and trading companies have played an especially strong role, and government efforts in trade promotion are much stronger than is the case in the United Kingdom. The section that follows examines these institutional mechanisms for promoting technology trade.

Government policies to facilitate technology trade fall into three broad and overlapping categories. The first serves to promote trade by putting buyers and sellers in contact with one another, by providing information that makes both sides aware of the potential benefits of transactions. The second set of policies deals with financial and insurance arrangements to complete or finalize the deals negotiated between buyers and sellers. Finally, technical training and development assistance policies often indirectly support technology trade.

Often the success of a country's policies to promote technology trade involving large contracts for supply of capital equipment and management services depends on *coordination* of the promotional, financial, and sometimes development assistance policy instruments. The strategy for achieving such coordination derives in large measure from longstanding patterns of government-industry relations unique to each country.

France

Credit or blame for the successes and failures in technology trade can be laid more directly at the feet of the French Government than any of the other Western supplier nations. Historically, the French state played a key role in modernization and industrialization.[18] Following World War II, the French embraced long-term "indicative" planning, a government-led planning system which not only involved setting production targets for the large state sector, but also incorporated the private sector in planning as well. The French state thus became a determined (if not always able) director of economic affairs, rather than a mere facilitator of private sector activities.

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[17] Taiwan reportedly bought Gabriel shipborne anti-ship missiles and Israeli technical personnel have trained Taiwan's navy. See *Far Eastern Economic Review*, July 9, 1982.

With initiative resting with the government, the private sector accommodated itself to that reality. As more and more nationalizations occurred (the most recent spurred by the election of the Socialist government of Francois Mitterrand in 1981), the distinction between the public and private sectors has blurred. Virtually all of the key high-technology firms (in nuclear power, telecommunications, aerospace and chemicals) are state-owned or operate with the government as a major partner. Close relations between government and private sectors are cemented by the fact that business and bureaucratic elites are both products of a small number of highly competitive government-run schools.[19] Government policies such as the recent merger of the Ministry of Research and Technology with the Ministry of Industry indicate that the French emphasize the link between industry and technology development.

The French state mobilizes and coordinates relevant public and private actors in putting together packages of equipment and services for prospective buyers. This strategy is designed primarily to win large contracts, particularly in public works, where a number of firms are involved, a wide range of services required, and financing needs substantial. The state seeks to initiate potential business: building on a foundation of friendly political and personal relations with Middle East leaders, public officials bring together appropriate French suppliers.

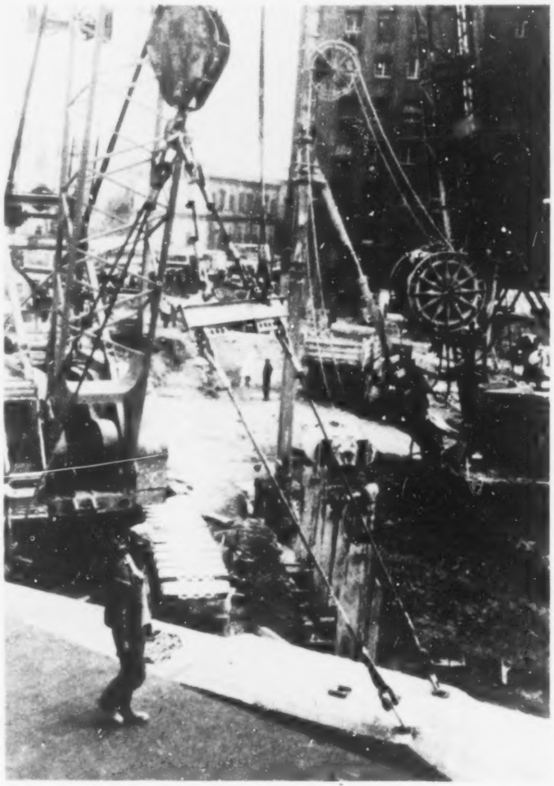

Photo credit: Middle East Economic Digest

Cairo subway under construction. French firms won a large contract to carry out this project

The primary body responsible for external trade is the Directorate of External Economic Relations (DREE), headed by the Minister of Foreign Trade in the Ministry of Economic Affairs and Finance. The DREE is assisted by the French Center of Foreign Trade (CFCE), which has personnel at home and abroad who gather information for French industry. The DREE provides a wide range of services—it coordinates the French commercial attachés abroad, carries out sectoral studies, and coordinates export credit, insurance, financial negotiations and technical cooperation.

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[18] See Andrew Shonfield, *Modern Capitalism: The Changing Balance of Public and Private Power* (New York: Oxford University Press, 1965), ch. 5, and H. Milward and S. B. Saul, *The Development of the Economies of Continental Europe* (Cambridge, Mass.: Harvard University Press, 1977), pp. 71-141.

[19] Ezra N. Sulieman, *Politics, Power and Bureaucracy in France: The Administrative Elite* (Princeton, N.J.: Princeton University Press, 1974).

The policies of the DREE are designed to conform with the priorities and objectives of the French plan for economic growth. In other words, exports are not promoted randomly but certain sectors are targeted for attention. For example, the French drive to expand and modernize telecommunications within France during the 1970's was paralleled by an export drive in that sector.

Linkage between commercial activity and diplomacy is reinforced by close cooperation between the DREE and the Ministry of Foreign Affairs, which has a division dealing with the North African and Near Eastern countries. In addition, the Ministry for Cooperation and its directorate of Economic Development play an active role in the DREE's export promotion. Export promotion is also a concern of government research institutes: the *Commissariat a l'énergie atomique* (CEA), for example, works with other government agencies in promoting sales of nuclear powerplants abroad. With the DREE at the center, export policy is thus coordinated with industrial, foreign and technology policies.

Not surprisingly, there are in France fewer private-sector organizations with central roles in export promotion than are present in some other supplier nations. One exception is the Franco-Arab Chamber of Commerce, founded by the Arab League, which has sponsored several conferences on technology transfer.[20]

Japan

In contrast to France, where the state has dominated decisions affecting technology trade, in Japan an extremely dynamic and competitive private sector acts as partner to high-level government officials in policymaking. While Japanese government officials less frequently than their French counterparts take on such high-profile roles in initiating commercial relations with Middle East nations, they have facilitated "national projects" by providing considerable government support, financial and otherwise. In advisory councils and semipublic organizations, public and private sector officials build informal consensus on export policies.

Since the immediate postwar period, Japan has been governed by a conservative political coalition under the Liberal Democratic Party which has developed strongly pro-business policies. This unparalleled and continuing rule has made it possible for bureaucratic decisionmaking normally to prevail, with the Ministry of International Trade and Industry (MITI) central in international economic policy.[21]

Throughout the conservative rule, overarching government goals have put great weight on improving Japan's international and domestic economic situation—at first through comparatively strong official controls on investment, tariffs, in an industrial policy characterized by targeting key industries, and promotion of exports. Japan's share of world manufacturing exports nearly equals that of the United States; only West Germany ranks higher. More recently, many concrete steps have been taken to open the Japanese economy to foreign firms, but Japan's striking export success nevertheless is still viewed with concern by trading partners.

If Japan lacks an official technology transfer policy, it is the one nation which has put technology most squarely at the center of its industrial policies. Since the early 1970's, Japanese public and private-sector leaders have promoted a structural shift in the economy away from energy-intensive heavy industries and toward technology-intensive industries, a view first articulated in a report by the prestigious Industrial Structure Council (an advisory body to MITI, made up primarily of industrial leaders). On the domestic scene, MITI and the Science and Technology Agency through funding approved by the Ministry of Finance, have sponsored wide-ranging R&D

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[20] Franco-Arab Chamber of Commerce, *Colloque sur la formation professionelle et le transfert de technologies* (Amman, May 27-30, 1979), and *Colloque sur les energies nouvelles* (Sousse, Tunisia, Oct. 27-30, 1980).

[21] Chalmers Johnson, *MITI and the Japanese Miracle* (Stanford, Calif.: Stanford University Press, 1982).

projects, many emphasizing commercialization of technological developments useful to industry.

On the international front, the impetus has been toward transferring technology and investment abroad. The Ministry of Foreign Affairs, and its Economic Cooperation and Middle Eastern Bureaus, while at times more cautious in its approach to Japanese overseas economic involvement has facilitated various development projects. In addition, the Japan External Trade Organization (JETRO) operates well-staffed and financed offices in the Middle East under MITI auspices which provide market surveys to Japanese exporters, and information about Japanese business to prospective foreign buyers.

The Japanese private sector has exceptionally diverse and numerous organizations involved in technology trade with the Middle East. There are more than 100 international trade associations and 34 overseas industrial and technical cooperation associations. Trade associations form the basis for industrywide collaboration on particular issues, including enforcement of voluntary export quotas agreed to by the government; during periods of recession they have helped form cartels.

These trade organizations, along with the largest Japanese firms and banks are organized in *Keidanren,* the Federation of Economic Organizations, an umbrella organization which has on many occasions taken a leading role in encouraging ties with Middle East. *Keidanren* leaders promoted, for example, Japan's first overseas oil development venture—the Arabian Oil Co.[22] In addition to the trade associations, Japanese banks play important roles in helping to finance overseas projects. The dozen commercial banks are each at the core of one or more groups of interrelated firms called *keiretsu.*

One of the most unusual features of Japan's private sector is the trading company. They number more than 6,000, but the top 10 are best known and handle 50 percent of Japan's exports and 60 percent of the country's imports. What distinguishes the trading companies is the wide range of activities they perform—including financing, investment, resource development, construction, organizing joint ventures, marketing, third-party trade, and information gathering.

All of the major trading companies have offices in the Middle East, and they often work in conjunction with Middle East governments and the government of Japan in suggesting projects for support. If the trading company is successful in persuading the Japanese government to offer assistance for a project, that firm and its *keiretsu*—related companies—usually receive the bulk of contract awards from the recipient government.

While the public and private sectors in Japan are made up of many and often strongly competing agencies and organizations, there is considerable coordination between the two sides. One of the devices for bringing the two sides together already noted is the more than 200 advisory councils which include representatives from the private sector. Virtually all government policies are shaped initially by the reports of these councils.

Through these councils and through the widespread authority that the government has to collect data, a high degree of confidence is generated in the recommendations that come out of these meetings. Informal ties—including school affiliations, common background in public corporations—help to reinforce the exchange of information between government and private sectors. Many semipublic organizations such as the National Oil Corp. are led by former MITI officials. In addition, specialized private sector organizations such as the Japan Cooperation Center for the Middle East bring business people in touch with their counterparts abroad.[23]

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[22] AOC was formed in 1958 by maverick private entrepreneur Yamashita Taro. The company gained a concession to explore for oil in the neutral zone between Kuwait and Saudi Arabia, and *Keidanren* leaders helped raise funding for the project.

[23] The JCCME holds annual conferences and publishes reports outlining developments in the Middle East, including specific legal and investment problems. See Japan Cooperation Center for the Middle East, *Dai nanka Chuto Kyoryoku Kenchi Kaigai,* Seventh Conference on Middle East Cooperation, report on the conference held Aug. 25-26, 1982.

In recent years, the Japanese Government has underwritten large overseas projects in the Middle East designated "national projects." The rationale is that no one Japanese firm could undertake such projects alone, but that Japan has an interest in fostering such cooperation with Middle East nations. A number of difficulties have arisen in conjunction with these projects, however. The Mitsui Co., with assistance from the Japanese Government and a number of private firms, undertook Japan's largest overseas project in Iran prior to the revolution. The huge petrochemical complex at Bandar Khomeni was 85 percent complete when the Iran-Iraq war flared, resulting in termination of activities. Japanese government and business have disagreed about how best to extricate themselves from the project, which resulted in severe financial loss for the Mitsui Co.[24] The somewhat ambiguous division of responsibilities between the two sectors has resulted in some disputes about how to resolve such issues of investment risk. The project is described in more detail in chapter 5.

Thus, while government and business sectors in Japan are made up of diverse and competitive elements, there are a number of formal and informal mechanisms for mitigating differences and forging common strategies. Perhaps more than is the case in any of the other Western supplier nations, the two sides act as partners in promoting technology trade.

United Kingdom

In contrast to the situation in France and in line with their tradition of economic liberalism, the British have given the government the role of facilitating rather than directing economic activity. Government officials are charged with improving the climate within which business decisions are made, through sponsorship of tripartite discussions involving government, business and labor. The decisions, however, are made largely by private sector actors. Government has thus sought to facilitate but not to initiate technology trade.

The British have also maintained a strict distinction between industries and banks. British banks, unlike their German counterparts, are forbidden by law from holding shares in British industries. This separation of corporate and financial institutions has apparently limited their ability to put together large package projects, judging from the fact that there are comparatively few British firms involved as large prime contractors for Middle East development projects.

Officially, British government activities in trade promotion are supervised by the British Overseas Trade Board (BOTB), with membership drawn from government and industry. The president of the BOTB is the Secretary of State for Trade, and the chairman is a leading industrialist. The BOTB typifies British response to economic issues—creation of a body that seeks to generate information and communication between the public and private sectors. The Board allocates funds, which in 1980-81 amounted to $165 million, for export services.[25] In addition to gathering information for exporters, it provides market entry guarantee schemes (MEGS) for smaller firms entering new markets, and it supervises the Overseas Projects Fund which helps United Kingdom companies identify overseas opportunities. Its regional committees such as the Committee for Middle East Trade (COMET) attempt to inform British firms of Middle East export opportunities.

In practice, the Department of Trade is the focal point for export promotion. Organized in geographical branches, the arms of the Department are the commercial sections of the British embassies abroad. Sometimes the Department works with other ministries—such as Industry, which has organized several Middle East trade missions. The Foreign Office only rarely plays a role. One exception to this general rule was a visit by Lord Carrington to Iraq several years ago which resolved some differences between the two nations and paved the way for improved commercial ties.

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[24] The Mitsui project was officially revived in 1983 after Iran agreed to provide financing, but before construction work resumed Iraq mined the harbor area near the site and Japan again delayed.

[25] The Board meets regularly to allocate funds for export promotion. See interview with John Biffen, Secretary of State for Trade, "The UK and the Gulf," *Middle East Economic Digest*, December 1981, p. 33.

More in keeping with the British Foreign Office tradition was the cancellation of Secretary of State for Foreign Affairs Francis Pym's scheduled trip to Saudi Arabia in 1983, due to Prime Minister Thatcher's unwillingness to meet with the PLO. The incident was viewed as potentially damaging to British exports. But while British officals have made numerous diplomatic trips to the Middle East, they have seldom acted as commercial salesmen.

While they are not as active as those in Japan, there are a number of private sector organizations involved in Middle East trade promotion, the oldest of which is the Middle East Association. The more recently formed Arab-British Chamber of Commerce has actually taken over from Arab embassies in Britain all the paperwork required to certify British goods for export.[26] The requirement that British goods carry a certificate of origin to assure compliance with the Arab boycott of firms doing business with Israel is met by the documentation center.

Trade promotion is also carried out by industrywide associations such as the Confederation of British Industries and by sectoral associations. In addition, the Association of Consulting Engineers assists members in design of major projects, a particularly strong suit for the British. In promoting British exports, quasi-public organizations such as the BOTB and the COMET, the likes of which do not exist in the United States, appear particularly important. In contrast to the situation in Japan, the British government takes a much less active role in trade promotion. The legal separation of corporate and financial institutions reduces the ability of the British to put together large packages, and suggests a partial explanation for the weaker export performance of the U.K. firms in Middle East markets.

West Germany

The Germans have given the lead to private sector firms which in turn benefit from their close association with banks. The trade promotion strategy of the FRG thus stands in marked contrast to the French, and more resembles that of the United Kingdom. Following World War II, German leaders constructed a liberal economic policy, the *sociale markwirtschaft,* which was designed to promote the free play of market forces.[27] Under the Economics Ministry, a free trade orientation abroad was promoted in the belief that economic progress would be export-led.[28] The success of the German export strategy is well known. Two features distinguish the German approach: German financial institutions have interacted closely with industrialists; and the private sector has been export-oriented and relatively unimpeded by obstacles in the form of government regulation.

Promotion of technology trade between West Germany and the Middle East is more the province of the private sector than is the case in either Britain or France. However, three ministries with varying perspectives are involved in technology transfer. The Ministry of Economics, which is organized geographically with responsibility for the Middle East divided between the countries in North Africa (the "poor states") and those east of the Red Sea (the "rich states"), holds firmest to the line that the private sector should initiate and negotiate technology trade.

The Ministry has well-defined views that technology transfer should involve extensive cooperation in training, research and (to a lesser extent) the eventual establishment of joint ventures. While the Ministry has often been criticized for not providing subsidies to exporters, there is a strong feeling that the German position will be strengthened in the long run by deals that are economically sound. This attitude perhaps explains the fact that the Germans have been more willing than the Japanese and other supplier countries to forgo technology-for-oil swaps, preferring to buy their oil on the open market.

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[26] The ABCC, which publishes the *Trade Information Bulletin*, is almost entirely staffed by Arab nationals. It has links to the Franco-Arab Chamber of Commerce, and both were formed at the instigation of the Arab League.

[27] See Henry Wallich, *Mainsprings of the German Revival* (New Haven, Conn.: Yale University Press, 1955); Edwin Hartrich, *The Fourth and Richest Reich* (New York: Macmillan, 1980); George Kuster, "Germany," in Raymond Vernon, *Big Business and the State* (Cambridge, Mass.: Harvard University Press, 1974).

[28] It should be remembered, however, that the FRG, like many other countries, has a variety of barriers to imports of equipment and services, including government procurement practices which reduce the "free play of market forces" in the domestic economy.

The Ministry of Research and Technology (BMFT) has traditionally followed a more interventionist strategy than the Economics Ministry. BMFT projects in developing nations often combine export promotion with development assistance. Middle East projects supported by the Ministry involve technology development and commercial application in fields such as nuclear, solar, and desalination. These projects normally follow government-to-govenment technical cooperation agreements, and involve exchange of personnel from private sector firms which provide equipment and technical services. As discussed in chapter 8, West Germany's success in medical equipment exports to the Middle East has been promoted by such agreements. In some instances, initial research and development pilot projects are first completed, and the ventures are then privately financed and sold to commercial enterprises.

While the new CDU-FPD government prefers to avoid direct subsidies, the BMFT maintains its more interventionist approach. In addition, the Ministry of Economic Cooperation (DMZ) handles a number of development assistance programs involving technology transfer, and financing agencies promote technical assistance to developing countries.

While all of these government activities are comparatively small-scale, they serve to support activities initiated by the private sector. There is, furthermore, a shared and growing perception in the Federal Republic that the economic interests of Germany and those of developing countries pursuing growth-oriented strategies are increasingly converging. The distinction between commercial opportunity and development assistance programs is thus not sharply defined. While government programs are less extensive than those in France, for example, the fact that public and private policymakers alike link German economic growth prospects to trade and technology transfer to developing nations indicates the positive context for technology trade.

Not surprisingly, German private sector organizations are particularly active in promoting technology trade. Among them, the Association of German Chambers of Industry and Commerce (DIHT), in which all businesses are required by law to be members, is the most important. The organization favors promotion of free trade, has bilateral agreements with many Middle East countries, and actually performs many of the services normally assigned to commercial sections of embassies. In addition, the DIHT plays a strong role in vocational training; German firms draw on the local German training programs in various fields when they bid on technical assistance contracts in the Middle East.

Other organizations, such as the Federation of German Industries, provide a wide range of services to exporters worldwide and are comparatively well organized and financed. The Near and Middle East Association (*Nah und Mittlost Verein-NMV*) has been in existence since the 1930's and represents 80 percent of German firms doing business in the Middle East. The Association promoted the establishment of the Orient Institute in Hamburg, a think-tank funded by the state of Hamburg and private foundations carrying out scholarly analysis on legal, political, and economic developments in the Middle East. The Association has identified growing opportunities for small and medium-size German firms in the Middle East market.

In summary, the institutional resources which supplier countries have utilized in promoting technology trade with the Middle East differ widely. French state leadership is most striking, as is the linkage of domestic industrial policy to export promotion. In Japan, both public and private sectors actively participate in export policymaking, and considerable coordination between them is achieved through a variety of semipublic organizations and advisory bodies. In Britain and West Germany there are a number of government agencies dealing with export promotion, but in both cases they play more a facilitating than a leading role. Private sector organizations involved in trade promotion in the Middle East are, however, comparatively stronger in West Germany, where technical training has been emphasized in technology trade, than in the United Kingdom. In France, Japan, and West Germany technology trade with developing nations is viewed as important to overall economic growth, while in France linkage to domestic industrial policy is particularly strong.

FINANCING TECHNOLOGY TRADE

Some have argued that government subsidies play a key role in influencing the export success of West European and Japanese firms. Broadly speaking, subsidies can be conferred through a wide variety of financial and other instruments used by governments to promote the growth of particular industries or sectors, including support for those engaging in exports and technology transfer. Such government assistance, it is often argued by critics, puts U.S. industries at an unfair advantage vis à vis their foreign competitors.

International trade agreements have helped to reduce direct trade barriers including tariffs during the post-World War II period. As supplier nations extend industrial policies, indirect assistance to domestic industries (through support for R&D, for example) has also grown.

The effects of indirect support, which help to build the technological or manpower infrastructure of industries, on export performance are much more difficult to assess than direct official export assistance. The focus of the discussion that follows is on the official and direct financial supports offered by supplier governments. However, it should be emphasized that domestic industrial policies supporting advanced technology industries may also be important to the growth of these industries.[29] Generally speaking, direct official subsidies have been used in sales of large plants and expensive equipment in developing countries, when technologies and equipment offered by competing suppliers are similar and when the recipient nation needs help in financing the purchase.

For some of the oil-rich states of the Middle East, such as Saudi Arabia and Kuwait, the availability of export financing by supplier governments has not been a major consideration. With ample capital available in the 1970's, these nations could arrange their own financing. But other countries have faced capital constraints—Egypt, and even better resource-endowed nations such as Algeria, Iran, and Iraq, because of other factors such as limited oil exports and military expenditure requirements.

Export credit and risk insurance have become indispensable for the sale of equipment and services to most Third World countries, and all industrial countries have developed programs to meet these needs. Such financing is provided through government-chartered export banks and insurance companies as well as private banks, banking consortia and private insurance companies.

International arrangements supported by a large number of OECD countries have attempted to limit the national differences in export financing, as discussed in chapter 2. In 1976 an informal "consensus" on credit terms was reached by the OECD, and rules were formalized in the 1978 Arrangement on Guidelines for Officially Supported Export Credits, which specified floors under permitted interest rates and ceilings on maturities for most officially supported export credits of 2 years or more.[30] Covered in separate agreements among OECD nations are aircraft and nuclear export credit financing rules. In addition, a General Agreement on Tariffs and Trade (GATT) code on subsidies was enacted in 1980 which allows countries to defend themselves against injurious competition from abroad in third country markets.

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[29] OTA's study of *International Competitiveness in Electronics* (Washington, D.C.: U.S. Government Printing Office, 1983) concluded that domestic industrial policies have had the greatest influence among various types of policies over international competitiveness in that industry.

All nations also have institutions which insure against the risk of extending credit to foreign buyers; the Berne Union is set up to harmonize policies in this area and to exchange information on credit worthiness. These international agreements have been established fairly recently, but the OECD arrangement in particular was strengthened and extended in 1983. Therefore, while many of the newer agreements were not operational during the past decade, since 1982 the subsidy element in government financing has been substantially reduced. (See chapter 13, sections dealing with the U.S. Export-Import Bank.)

Insurance Programs in France

France has a number of government-run organizations involved in export financing. A 1978 report by the French Commissariat Général du Plan attributes the growth of French exports in the Third World to the rapid expansion of export credits in the 1970's, about half of which went to developing countries.[31] While this conclusion is disputed by many, the fact is that the French Government does offer somewhat more extensive financing services than many other supplier countries. These differ in degree rather than in kind. While some would point to declining French market shares in the Middle East as evidence that these programs have not been effective, others would argue that the decline might have been worse in the absence of them.

The Compagnie Francaise d'Assurance pour le Commerce Exterieur (COFACE) is a quasi-public joint stock company which provides export insurance. COFACE has insured about 27 percent of exports in recent years against a wide variey of political and economic risks.[32] To qualify, goods must have no more than 10 percent foreign content (except for components manufactured in the European Community). The insurance covers 85 to 90 percent of the financed amount for supplier credits. Extensive coverage is available to exporters and banks in the form of short-term programs with repayment terms of less than 3 years. The total budgetary cost of the COFACE program in 1980 (including commercial, political and exchange rate insurance) was estimated at $108 million.[33]

Insurance Programs in the United Kingdom

In Britain, export credit insurance is the principal responsibility of the Export Credits Guarantee Department (ECGD) under the Secretary of Trade. The percentage of British exports insured by the ECGD rose from 8 percent in 1947 to 33 percent in 1982, and foreign content rules are relatively liberal. About 75 percent of the insurance covers short-term transactions of less than 6 months; these transactions in 1980 totaled $33.4 billion. Coverage is comparable to that offered by COFACE.

The ECGD has several special programs aimed to assist large capital projects: a cost-escalation scheme protects against cost increases for firms with capital goods contracts of more than 2 years; the Supplemental Extended Terms Guarantee provides help for exports of production engineering goods; contractor guarantees protect firms involved in overseas consortia or joint ventures.[34] France and the United Kingdom have offered perhaps the widest ranges of insurance and other export financing programs (including exchange rate insurance and mixed credits) during the past decade.[35]

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[30] OECD, *The Export Credit Financing Systems of OECD Member Countries* (Paris: OECD, 1982), pp. 7-12.

[31] Commissariat Général du Plan, *Rapport du Groupe Charge d'Etudier l'Evolution des Economies du Tiers-Monde et l'Appareil Productif Francais* (Paris: CGP, 1978), p. 21.

[32] Lawrence G. Franko and Sherry Stephenson, *French Export Behavior in Third World Markets* (Washington, D.C.: Center for Strategic and International Studies, Significant Issue Series, 1980), p. 20.

[33] Export-Import Bank of the U.S., *Report to the U.S. Congress on Export Credit Competition and the Export-Import Bank of the United States*, October 1981, p. 44.

[34] *ECGD Services* (London: HMSO, 1982), pp. 9-10.

Insurance Programs in Japan

In Japan, MITI's Export Insurance Division offers insurance for exports through a range of programs, some of which have been recently expanded. In 1981, coverage of preshipment risks for the hardware portion of large plant contracts was enlarged. Most of the insurance is offered in short-term programs, which covered a total of $48 billion in 1980. Japan is probably the most frequent user of local cost support,[36] which is seen as an integral element of assistance to developing countries. The Export Insurance Division of MITI covered almost $60 billion in total exports in 1980. The government also offers exchange rate insurance.

Insurance Programs in West Germany

In West Germany, insurance is provided by a consortium authorized by the government. The two leading members of the consortium are Treuarbeit, a publicly held corporation that does not insure directly, and Hermes, a private insurance company. The Interministerial Committee for Export Guarantees sets guidelines for coverage and the Bundestag sets annual limits for total exposure (DM 150 billion in 1980). In granting cover, a distinction is made between business with private firms and transactions with foreign governments, with coverage for protracted default available in the latter case.

Hermes alone can make decisions about cover up to DM 2 million,[37] and only after such insurance has been arranged can firms obtain financing through other financial institutions. Compared with the French and British insurance schemes, German coverage has been somewhat less comprehensive and slightly more costly, though the differences are not great. Like Japan, Germany offers considerable local cost support.

Export Credits in France

Export credits, as opposed to insurance, are in France handled by the Banque de France, and Banque Francaise du Commerce Extérieur (BFCE), and commercial banks, most of which are now nationalized. France supports the most extensive officially subisidized export financing system of any of these nations. In 1981, it was estimated that French Government subsidies to long-term export finance totaled $466 million (compared with $382 million for the United Kingdom, $203 million for the United States, $79 million for Japan and zero for Germany).[38] (Table 111 in chapter 13 provides comparative information on credit subsidy and interest rates in nations under review here and in the United States.) France and the United Kingdom have been the countries with largest government subsidies for export financing, but in the latter case the subsidy element has been largely eliminated since 1982.

The BFCE has authority to provide financing in foreign currencies. In the case of medium-term financing (2-7 years), the BFCE first endorsed the loans, which are provided at preferential rates by the Banque de France.

In recent years, the value of new BFCE loans increased from $10.6 billion in 1980 to $11.7 billion in 1982. In addition, the size of France's mixed credit program grew considerably, by approximately 25-30 percent annually. (In 1980, the aggregate value of these credits was $1.7 billion, according to the U.S. Export-Import Bank.)[39]

French tax policies deserve mention. Income earned abroad by French companies is not taxable, nor is 95 percent of dividends received by French firms from foreign subsidiaries. Companies may set up tax-deductible reserves to cover export credit risks, development and other promotional costs. Foreign losses are deductible from domestic income taxes even though foreign profits are not taxed. In 1983, the French Government also eased foreign exchange restrictions so as to boost exports by small firms.

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[35] Export-Import Bank, *Report to the US Congress . . .*, op. cit., p. 5.

[36] Local cost support is credit or guarantee support for costs incurred in the purchasing country that are associated with the export transaction.

[37] Export-Import Bank, 1981, op. cit., pp. 46 and 102.

[38] Export-Import Bank of the United States, *Report to the U.S. Congress, Export-Import Bank of the United States*, September 1983, pp. 5-8.

[39] Ibid., pp. 43 and 48.

Export Credits in the United Kingdom

The United Kingdom also offers comprehensive government programs supporting export finance. A new Projects and Exports Policy Division was established within the Department of Trade in 1980 to focus on exports to Third World markets. The ECGB uses refinancing arrangements with private bankers to ensure adequate funding at competitive rates. U.K. banks are thus able to provide export credits at OECD consensus terms, because the government pays the banks a direct subsidy to cover the gap between the credit and the normal bank lending rate. During 1980, the ECGB provided financing for $4 billion in long-term financed exports and $17.9 in medium-term financed exports.

Export Credits in Japan

The Export-Import Bank of Japan is the primary vehicle for government-supported export financing. As in West Germany, the subsidy element in Japanese export credits has been comparatively low. Owned by the government and overseen by the Ministry of Finance, the bank has channeled less than 10 percent of all its loans and guarantees to the West Asia region (which includes the Middle East), with the vast majority of investments in the petrochemical and chemical sectors.[40] Short-term credits are provided by commercial banks, and longer-term credits are refinanced by the Export-Import Bank at preferential rates in combination with some commercial financing.

Japan's Export-Import Bank is one of the largest banks of its kind, with total credit authorizations valued at $7.35 billion in 1981. The Bank administers long-term development loans, which are not considered export credits because they are not tied to procurement. These loans often are linked to imports of fuels or raw materials. In 1981, a mixed credit program was established to match programs in Europe. This program is administered by the Overseas Economic Cooperation Fund, a public corporation which provides loans to Japanese corporations and foreign governments for financing various development programs. In Japan, as in West European nations, official export credits are thus often awarded in conjunction with development assistance projects by the Overseas Economic Cooperation Fund.

A distinguishing feature of Japan's approach has been the designation of some overseas projects as "national projects," such as the Mitsui petrochemical project in Iran. In that case, the risk associated with Japan's largest overseas effort was spread among a group of firms in consortia financing. The number of firms was further expanded as the project fell on hard times. In addition, the government stepped in with additional loans and assistance. The core group of Mitsui firms suffered heavy financial losses due to project delays caused by the Iranian revolution and later damage during the Gulf war, which precluded resumption of construction work.

Export Credits in West Germany

German financing for exports comes primarily from the private sector, particularly commercial banks, and the subsidy element has been low. The willingness of commercial banks to extend export credits owes much to their close relations with corporations. As equity shareholders in export-oriented firms, the banks are sensitive to the importance of export financing. In addition, the KfW (Kreditarstalt für Wideraubau), a public agency with private sector representation on its Board of Directors, provides long-term financing to German exporters selling capital goods to developing countries. Because of a shortage of government funding, the KfW has increasingly gone to capital markets to finance large projects, with the result that the blended rate offered has been at or above the OECD rate.

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[40] Nihon Yushutshunyu Ginko (The Export-Import Bank of Japan), *Gyomu Hokokusho* (Annual Business Report) fiscal year 1981, pp. 10, 17, 20.

Photo credit: Aramco World Magazine

The Japanese tanker *Sun River* is shown taking on the first shipment of liquefied petroleum gas (LPG), from one of the twin loading berths at the tip of the 10-kilometer-long trestle at the Ju'aymah Marine Export Terminal, Saudi Arabia

A second source of capital at preferential rates is the AKA (Ausfuhrkredit GmbH), a private commercial bank syndicate which has access to a rediscounting facility of the Deutsche Bundesbank and the KfW. One type of credit is available at preferential rates for medium-term supplier credits to developing countries, and this type of financing can be combined with other financing at market rates. In addition, the government offers mixed credits, which combine development assistance and commercial financing at a combined effective rate of about 8 percent.

In contrast to the situation in France, the private sector rather than the government has played a more important role in export financing. Because the German commercial banks work so closely with corporations in financing exports, there is less need for direct government action.

Summary

The conclusion that can be drawn from a review of export financing in these supplier nations is that all of them have similar packages of policy instruments. While the subsidy element has been higher in French and British export credits during the past decade, since 1982 subsidies have been greatly reduced everywhere but in France. French, Japanese, and British financing and insurance programs are comparatively more extensive in coverage and funding. As shown in table 102, Japanese, French, and British official programs cover a much larger share of exports than do U.S. and West German programs. German commercial banks work closely with corporations, reducing the need for direct government assistance. All of the suppliers have expanded mixed credits, combining loans at market rates with development assistance funding. In many cases,

Table 102.—Comparison of Official Export Support Programs, 1982

	A ($ billion)	B ($ billion)	C (%)
France	$ 96.2	$0.29367	30.6%
West Germany	176.4	0.16461	9.4
Japan	137.7	0.51862	37.7
United Kingdom	97.2	0.39270	40.4
United States	212.2	0.12149	5.7

KEY:

A = Total Merchandise Exports, in current $U.S. billion.

B = Officially Supported Export Transactions, in current $U.S. billion. Includes total value of all exports supported by official long and short term loans, insurance and guarantee authorizations for the year, as reported by supplier governments. In the case of the United States fiscal year 1982 data are given; for other countries data are for calendar 1982.

C = B ÷ A.

SOURCE: Export-Import Bank of the United States, data provided to OTA in May 1984.

programs include extra measures (such as local cost support and exchange rate insurance) to support exporters.

Analysis of technology transfers in chapters 5 through 9 indicates that in a few notable cases foreign government financing has strongly influenced the awards of contracts. In aircraft sales and telecommunications contracts, a few widely publicized cases have received public attention. The instances where export financing appears to have had the most significant effects are those involving sales of very costly equipment which is roughly comparable to that available from other suppliers, and particularly where foreign suppliers are public corporations or firms closely connected to government programs.

Even in those cases, however, other factors have influenced the outcome. Those factors include U.S. controls on exports as well as corporate strategies of some U.S. firms (including decisions to focus on domestic or export markets). The vast majority of technology trade transactions are not determined by foreign government financing, but rather by the price and quality of technology offered, the willingness of firms to provide after-sale services required for technology transfer, historical and political relations between buyers and sellers, and marketing prowess of private sector firms. Nevertheless, official export financing is an important support offered to firms doing business overseas, and it has at times been a critical factor in Middle East sales.

In the last analysis, the organizational resources of the government agencies involved, and the pattern of business-government relations may be as important as the dollar value of financing support from supplier governments. In these Western supplier nations, governments rarely block and usually facilitate, or in the case of France coordinate, export financing activities. Public and private sectors share a common view that exports to developing nations are increasingly important. The precise contribution of this comparatively supportive context is difficult to measure but nevertheless important. In few instances, however, have actions taken by governments alone determined the outcome of competition for contracts.

DEVELOPMENT ASSISTANCE AND TRAINING POLICIES

In comparison to other policies affecting technology trade with the Middle East, development assistance per se occupies a comparatively minor role. Because oil-exporting nations such as Saudi Arabia and Kuwait are themselves aid donors, they receive no development assistance from supplier governments. Other Middle East nations, including lower income oil-producing nations such as Egypt and Algeria, do receive development assistance. Egypt in 1981 received $1.1 billion in economic assistance from the United States, or about 15 percent of that provided by the United States worldwide.

In addition to development assistance policies focusing on help for the poorer nations, supplier governments also participate—sometimes in conjunction with private sector firms—in technical assistance and training projects in the richer developing countries. Underlying both types of programs are considerations of foreign policy—the responsibility that industrialized nations have to assist developing countries, as well as the desire to foster political alliances with friendly nations.

In addition, but less often overtly emphasized, are considerations of commercial gain associated with all development assistance.

The supplier nations in West Europe and Japan have placed considerable emphasis on commercial considerations in their development assistance programs. This commercial perspective is reflected in the fact that the OECD Development Assistance Committee was studying in 1983 the adequacy of development assistance to export expansion and diversification.

France

French development assistance still reflects the notion of *le besoin de rayonnement* (the inherent need to spread one's ideas or values to other parts of the globe): French programs stress education and training.[41] The Ministry of Cooperation, with 10,000 people, provides grants and indirect funding for technical cooperation. It shares responsibility with other agencies such as the Directorate-General for Cultural, Scientific and Technical Relations. While these programs are not particularly well coordinated or given high priority in Paris, they have ensured a considerable French presence overseas.

In 1981, French expenditure for bilateral technical cooperation exceeded that of any other nation, according to OECD statistics, including the United States; France also officially supported far more students and trainees than any other nation—more than 36,000 in comparison with about 9,000 for the United States in the same year.[42] (Many more foreign students, most of them financing their own educations, study in the United States than in France, however.)

By the mid-1970's, France sent abroad one-third to one-half of all technical personnel from developed countries working in developing nations. Many of these people work in education, some also assisting in research efforts. The French have long been aware that the relations established between French and developing-country technical personnel may lead to the choice of French products and equipment. France has also been at the forefront in using mixed credits. In 1980, mixed credits, involving 3.5 percent interest rates and 20-year maturity periods on the aid portion of the loans, amounted to about 10 percent of the nation's total export credits, totalling $1.7 billion.[43]

The United Kingdom

In Britain technology transfer through education and training has been handled by the private sector, with some assistance from the government. Many large firms doing business in the Middle East, especially telecommunications firms, run training centers for students from abroad. In addition, the British Council teaches English-language skills abroad and operates a full range of programs in the Middle East. Nationalized industries such as British Electricity International offer specialized programs in the Middle East. This ad hoc approach has been made more necessary by cuts in development assistance under the Conservative government.

The British Minister of Overseas Development articulated a new emphasis on "mutual advantage" in development assistance when he stated: "We believe that it is right at the present time to give greater weight in the allocation of our aid to political, industrial and commercial considerations alongside our basic development objectives."[44] Reflecting this emphasis, the U.K. government announced a new mixed credits program in 1981 which was estimated to cover $230 million to $460 million of overseas business.[45] The tied share of Britain's aid has always been comparatively high; critics have argued that the result has been to foster high-technology and capital-intensive projects at the expense of others.[46]

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[41] Steven H. Arnold, *Implementing Development Assistance* (Boulder, Colo.: Westview, 1982), pp. 11 and 18.

[42] OECD, *Development Cooperation—1982*, op. cit., p. 240.

[43] Export-Import Bank of the U.S., *Report to the Congress . . .*, 1981, op. cit., p. 43.

[44] Arnold, op. cit., p. 147.

[45] Export-Import Bank of the U.S., *Report to the Congress . . .*, 1981, op. cit., p. 79.

[46] Select Committee on Overseas Development, *The Pattern of United Kingdom Aid to India* (First Report, Session, 1978-79, HMSO 1979), p. xxiv, cited by Arnold, p. 157.

Japan

Japan's government economic cooperation programs, some of which are carried out in conjunction with private sector organizations, have up until the past decade been comparatively small-scale and oriented toward Asia. The amount of Japanese ODA flowing to the Middle East increased rapidly in the 1970's, reaching a peak of almost one-quarter of the total in 1978, when large shares went to Iran and Egypt.[47]

While the Japanese Government has pledged itself to expand Japan's ODA rapidly in the next few years so as to raise the percentage contribution of GNP to a level more on a par with other OECD nations, in 1981 and 1982 Japan's ODA fell in dollar value.[48] In 1983, the Government of Japan announced that its goal of boosting ODA was unattainable, due to budget deficits and other factors.

The Ministry of Foreign Affairs is the primary body responsible for official economic cooperation; the Overseas Economic Cooperation Fund (OECF) provides assistance to projects which may be politically important but not commercially viable, and the Japan International Cooperation Agency (JICA) runs training programs for people from developing countries both in Japan and abroad. The OECF and the JICA receive direction from parts of the government with different mandates, leading to problems in coordination.

Official policy statements emphasize technology transfer, along with financial assistance, as essential components of aid. Technology transfer to Middle East nations is viewed as a particularly important component of Japan's relations with these nations.[49] But despite the rhetorical support for technology transfer, the number of Japanese technical experts in the Middle East supported by government programs remains comparatively small. In 1981, there were about 300 overseas volunteers (in JICA programs) in the Middle East, and about 3,000 people went as team members on expert survey visits to the region.[50] Even more important are the efforts of private companies in support of various technical assistance activities.

As mentioned earlier, Japan has recently greatly expanded its mixed-credit program; in fiscal year 1981 $1.9 billion in concessional credits were to be funded by the OECF. In comparison to other OECD countries, Japan's aid has been more in the form of loans than grants.

West Germany

The West German development assistance program is characterized by administrative separation between the policymaking agency (the Ministry of Economic Cooperation), and two implementing agencies: the GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit) in charge of technical assistance and the KfW, which, as mentioned above, handles financing. Since the early postwar period, the German Government has relied on a host of independent organizations to carry out development assistance projects elsewhere handled by governments. One (DED) is responsible for training, another (DES) for arranging conferences and seminars, still another (DIE) for research and consultancy.

The German Development Co. (DEG) promotes cooperation between German and developing-country enterprises through equity investments and loans. DEG is a partner in a joint venture with Saudi Arabia, the purpose of which is to evaluate projects and bring corporate partners together. The GTZ has subcontracted 200 technical training projects to outside private consultants. A number of churches, political foundations, and private organizations also receive grants to carry out development programs.

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[47] Japan International Cooperation Agency, *Chukinto ni tai suru JICA Kyoryoku Jigyo no Gaiyo* (Tokyo: JICA, 1982), p. 3. During that year more than 10 percent of Japan's ODA went to the Middle East.

[48] *JEI Report*, No. 23B, June 17, 1983, p. 4.

[49] See Ministry of Foreign Affairs, *The Developing Countries and Japan, Japan's Economic Cooperation* (Tokyo: MFA, 1979), p. 20. One industry leader assessed technology transfer to the Middle East in the following way: "It is important for Japan to develop friendlier relations with such oil-producing countries as Saudi Arabia, the UAE, Iraq and Kuwait in the Middle East, regardless of its oil purchase from these countries. Economic and technical cooperation is considered instrumental in cementing these relations. As oil-producing states have abundant capital available for development, it is necessary to step up technical cooperation based on technology transfer through such cooperation programs as formulation of economic and social development plans, export assignment and acceptance of trainees." Hiroshi Irisawa, "Technical Cooperation Toward Middle East Countries," *Digest of Japanese Industry and Technology*, No. 175, 1982, p. 12.

[50] *Japan International Cooperation Agency*, 1982, p. 27.

One distinguishing feature of German development assistance is the comparatively strong emphasis placed on technical assistance: between 1976 and 1980 about one-third of the bilateral German development assistance went toward technical assistance, a level second only to that of France.[51] According to OECD data, during 1980 the level of German "technical cooperation expenditures" ($990 million) for example, exceeded those of the United States ($724 million).[52] In the 2 years following, the level of U.S. assistance of this type was greater, but Germany still ranked third after France and the U.S. in its bilateral disbursements.

As mentioned earlier, West German technical assistance has been particularly prominent in some of Middle East nations, including those rich in oil but needing technology transfers. West Germany also supports independently through government funds a large number of students and trainees, numbering almost 22,000 in 1982. In addition, Germany ranks second only to the United States in the value of private voluntary contributions for development cooperation.

The level of untied bilateral aid is higher in West Germany than in most other supplier nations. Many of the government-sponsored projects fall somewhere between commmercial promotion and development assistance. Mixed credits have been utilized, though less frequently than in some other countries; the strength of German financial institutions such as the KfW and the private AKA reduce the need for mixed credits.

Development assistance is carried out by a variety of organizations in these supplier nations. Technical assistance receives considerable emphasis in French and German programs, while Japanese policy statements indicate that government officials view this as a priority area. The development assistance policies of these nations all have a strong commercial flavor.

Mixed credits is but one indication; involvement by German private organizations, some of which promote joint ventures in the Middle East, is another. It is not an exaggeration to say that all of these nations view commercial gain as concomitant with development assistance. Generally speaking, West European and Japanese policymakers have not been reluctant to consciously emphasize the commercial side of development assistance.

MULTILATERAL POLICY FORMATION: THE EUROPEAN COMMUNITY AND THE EURO-ARAB DIALOG

While the multilateral dimensions of policies affecting technology transfer to the Middle East are clearly less salient than the national policies discussed earlier, they are worthy of consideration. All supplier nations provide development assistance through multilateral agencies such as the United Nations, but the relative share of multilateral assistance in the development assistance of these nations has fallen in recent years from 31 percent in 1977 to 23 percent of official development assistance in 1981.[53]

Through a variety of other organizations such as OECD, the International Energy Agency, and the International Monetary Fund, supplier governments attempt to coordinate their efforts, some involving technology transfer. However, OECD has been involved primarily in studies of development issues rather than implementation of programs. There are currently few coordinated efforts by OECD nations to provide assistance to Middle Eastern countries. Assistance provided to Lebanon has been one of these.

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[51] Arnold, p. 49.

[52] OECD, *Development Cooperation*, 1982, p. 240. In 1982, France ranked first, the United States second, and West Germany third in expenditures for technical cooperation, according to OECD data. See ibid., p. 204.

[53] OECD, *Development Cooperation*, idid., p. 72. In 1982, multilateral contributions rose to 28% of ODA, but this was viewed as a temporary phenomenon, which reflected a bunching of payments to IDA. See OECD, *Development Cooperation*, 1983, pp. 97-98.

While such multilateral efforts have been important, more specialized regional programs involving these nations are particularly worth consideration, not only because the results of ongoing efforts such as the Euro-Arab dialog illustrate some of the problems associated with multilateral approaches, but also because these programs have at times been viewed as running at cross-purposes to those of the United States. In addition to bilateral policies, West European nations have used the institutions of the European Community to manage their relations with the Arab world. European leaders have been stimulated by the prospect of linking Western technology to Arab capital in development efforts. Arab countries have looked to Europe not only as model of economic integration, but also for allies in pursuit of resolution of Middle East conflicts.

Background to Multilateral European Programs

Despite the fact that the ingredients of a significant political and economic bargain have been apparently available, the history of the Euro-Arab dialog over the last decade reveals a persisting problem in defining terms acceptable to both sides—the European Community and the Arab League. There are several reasons for this difficulty. First, the large number of participants has made it difficult to reach agreement. Discussions have been delayed by the inability of Arabs in particular, but also Europeans, to agree among themselves. Some states have found bilateral deals more attractive than multilateral arrangements.

A second problem has been the European desire to stress economic issues in contrast to the Arab view that political concessions should precede economic agreement.[54] A third constraint has been the role played by outside states, particularly the United States. In the early 1970's American leaders viewed European overtures to oil-producing states as undermining the common economic interests of supplier states and impeding U.S. efforts to promote a peace settlement.[55] Despite slow progress, the Euro-Arab dialog is important as an example of a multilateral attempt to coordinate policy in technology trade and transfer—one in which the United States has not participated.

European Community (EC) interest in cooperating with the Middle East predates the oil crisis of 1973-74 and should be placed in the context of relations with former colonies and the Third World in general. In the late 1960's the EC began a series of trade-related initiatives with the "ACP countries" in Africa, the Caribbean and the Pacific which resulted in a preferential trade package finally agreed on at Rome in 1975. At the same time, there was growing interest in complementary accords with Arab and other countries in the East and South Mediterranean rim.[56]

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[54] On the Arab view, see Nijmeddin Dajani, "The Euro-Arab Dialogue: The Arab Viewpoint," in *Euro-Arab Cooperation*, E. J. Volcker (ed.) (Leyden: A. W. Sijthoff, 1976), ch. 13 and Dieter Bielenstein, *Europe's Future in the Arab View* (Saarbracken: Verlag Greitenback Publishers, 1981). For the European view, see John P. Richardson, "Europe in the Middle East: Shaping a Political Role," *SAIS Review*, winter 1981-82, pp. 107-17; Udo Steinback, "Western Europea and EEC Policies Towards Mediterranean and Middle East Countries"; Colin Legum, *Middle East Contemporary Survey*, vol. 12, 1977-78 (New York: Holmes & Meier, 1979), pp. 40-48; Stephen J. Artner, "The Middle East: A Chance for Europe?" *International Affairs*, London, vol. 56, summer, 1980, pp. 420-442.

[55] See D. J. Allen, "The Euro-Arab Dialogue," *Journal of Common Market Studies*, vol. XVI (June 1978), pp. 323-342; Adam Garfinkle, "America and Europe in the Middle East: A New Coordination," *Orbis*, vol. 25, No. 3, fall 1981; Alan R. Taylor, "The Euro-Arab Dialogue: Quest for an Interregional Partnership," *Middle East Journal*, vol. 32, No. 4, 1978, p. 443.

[56] See H. A. H. Gadel Hak, *The Mediterranean Policy of the European Community* (Doctoral Dissertation: University of Amsterdam, 1978). See also Samy Afify Hatem, *The Possibilities of Economic Cooperation and Integration Between the European Community and the Arab League* (Munich: Florentz, 1981).

The October war and the oil embargo of 1973 provided a stimulus to the dialog. In November 1973, the EC issued the Brussels Declaration urging bilateral cooperation agreements, and stating European opposition to Israeli occupation of territories held since 1967 and support for the rights of Palestinians in a Middle East peace settlement. A month later the Europeans announced their support for "negotiations with oil-producing countries on comprehensive arrangements comprising cooperation on a wide scale for the economic and industrial development of these countries, industrial investments and stable energy supplies to the member countries at reasonable prices."[57] Two sets of negotiations followed, one concerning bilateral cooperation agreements and the other the Euro-Arab dialog concerning issues of common concern to both sides.

Bilateral Cooperation Agreements

Identical bilateral cooperation agreements have been concluded between the EC and Israel as well as 11 of the 20 Arab League states. These agreements provide preferential trade treatment permitting entry of Arab manufactured goods into European markets unhindered by tariffs. (However, it is important to note that the few industrial products produced by Arab states, including textiles and petrochemicals, are not covered by these agreements.)

In addition, the agreements promote financial and technical assistance. While the amounts of funding are relatively low, they carry weight in the sense that they provide a framework and are usually used in conjunction with other investment funds. A much wider range of cooperation—in science, technology, environment, sales promotion and marketing, industrial management, and private investment—is anticipated.

These agreements provide a context for ongoing cooperation. Some Europeans expect that such agreements will be established with the wealthy Gulf states, perhaps via the Gulf Cooperation Council, as well. The bilateral character of the agreements has allowed the Europeans as a group to maintain good relations with individual states even when relations between the regions have deteriorated or cracks emerged in the pan-Arab movement. European cooperation with Egypt, for example, did not terminate with the nation's ouster from the Arab League because of its participation in the Camp David accords. These bilateral cooperation agreements have been important in setting the stage for private sector involvement in Middle East nations, since they signify official government support for commercial interactions.

The Euro-Arab Dialog

The second and more political negotiations of the Euro-Arab dialog have been characterized by a tension between the Arab desire to focus on political issues and the European determination to separate politics from economics. The dialog was launched in July 1974 to discuss negoitating procedures. However, work was delayed because of two issues: the European decision to conclude a cooperation agreement with Israel, and Arab insistence on Palestinian representation in their delegation. The former issue remained a source of irritation, while the latter was resolved by the "Dublin formula," which ruled that delegations should be homogeneous rather than serving as representatives of particular states or groups. Palestinians could therefore participate without raising the representation question.

Since the first deliberative session held in Cairo in 1975, technology-related issues have received attention. Working committees were set up to handle a variety of issues, including scientific and technology cooperation. The meeting produced a joint memorandum which recognized the dialog as a "product of joint political will that emerged at the highest level with a view to establishing a special relationship between the two groups." More specifically, it called for "the development of the Arab world in its entirety and of lessening the technological gap separating Arab and European countries."[58]

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[57] Quoted in Taylor, op. cit., p. 431.

The progress of the dialog between 1975 and 1978 was not dramatic, but some important projects were initiated which relate to technology trade. The working committee on industrialization proposed creation of Euro-Arab resource and information centers, and a study of programs for education and training in standardization and quality control. In addition, a subcommittee dealing with petrochemicals proposed market studies in the Arab world and Europe, but the Europeans were less enthusiastic than their Arab counterparts about this proposal. In late 1983, moreover, a draft investment convention was under discussion at a technical meeting held in Tunis.

The working committee on scientific and technological cooperation identified a number of areas for study, including the feasibility of an Arab water desalination and water resources center, an Arab polytechnic institute, and a study of the scientific infrastructure for oceanography in the Arab world. Finally, members from both the industrialization and technological cooperation committees proposed the establishment of a Euro-Arab center for technology transfer to be located in the Arab world.

The work of the dialog was suspended following the signing of the Camp David accords in 1979. As a show of their displeasure with Egypt, the Arabs suspended that nation from the Arab League and moved the headquarters of the organization from Cairo to Tunis. The bureaucratic disarray caused by the ouster of Egyptian officials and the loss of Arab League records was probably just as damaging to negotiations as the decision to suspend discussions. These delays caused by political events thus much more negatively affected the Euro-Arab Dialog than the bilateral cooperation efforts.

For the last 4 years, leaders on both sides have sought to renew the dialog. In June 1980, the Europeans took the initiative in issuing a declaration calling for relaunching of the dialog. An economic task force was organized to secure agreement on issues such as the Euro-Arab technology transfer center prior to a high-level ministerial meeting scheduled for the summer of 1981. That meeting, however, never occurred. Arab opposition to European participation in the Sinai peacekeeping force, and later the war in Lebanon strained relations within the Arab nations. By late summer 1982, the Arab League proposed resumption of the dialog. The European response was uncertain in the midst of American efforts to mediate between Israel and Lebanon.

In late 1983, the fifth session of the General Commission of the Euro-Arab Dialog was convened. While no statement was issued at the end of the meeting, it was significant that high level political discussions were resumed for the first time in 4 years.

Many EC officials are skeptical that the Euro-Arab dialog has a viable future. The stalemate of the period following 1979 highlights the fact that the dialog has been strongly affected by political developments. By linking economic and political issues in the framework of the dialog, it has been difficult to pursue cooperation at the technical or economic levels without resolution of political problems. In the last analysis, it is probably true that politics will never be far removed from these discussions if negotiations require a large group of countries to coordinate their positions. This may explain why European nations acting independently have been more successful in pursuing economic and technical cooperation with individual Middle East nations.

The Euro-Arab dialog is nevertheless likely to remain a feature of relations between the two regions for some time to come. The common interests identified a decade ago have changed, but in some ways become more important. The Europeans are less dependent on Arab petroleum in a period of excess supply and failing prices, but they have become increasingly involved in Arab markets in order to sustain export levels during a time of recession in the West. The Arabs still look to Europe for a somewhat different political perspective from that of the United States concerning the Middle East, and Europe will become more and more important as a market for Middle East products such as petrochemicals. The multinational character of the discussion reveals the perceived common West European interest in building bridges to the Arab world.

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[58] Taylor, op. cit., *The European Community and the Arab World*, p. 29.

Technical issues concerning industrialization and trade may occupy a more central place in the dialog during the years to come. On the one hand, Arab nations have long been interested in focusing attention in the dialog on commercial cooperation in petrochemicals and refining. Simply put, the Arab nations wanted outlet guarantees for their petrochemical production, most of which will come onstream in the late 1980's. While cautious, the Europeans supported a market study of a dozen basic petrochemical products which was complete prior to the suspension of the dialog in 1979.

Working groups have continued discussions on petrochemical trade issues. However, European industrialists remain skeptical of the whole process and there are indications of possible protectionist responses when Arab petrochemicals hit European markets. The EC position has been that the dialog could be used to stave off such potential trade frictions with the Middle East, but it is not clear that industry can be persuaded. Arab nations maintain great interest in resuming such talks. If and when the dialog is resumed wholeheartedly, such economic issues may be a central focus of concern.

POLICY VARIATION AND THE FUTURE OF WESTERN TECHNOLOGY TRADE

There is considerable variation in the approaches various supplier governments have taken to policies affecting technology trade with the Middle East. While none of these nations have developed clearly articulated and coherent technology trade policies, all of them have an array of supportive policies. Nevertheless, the strongly state-led approach of France contrasts sharply with the lower-profile and more indirect supports offered by the government of the Federal Republic.

A second feature, which distinguishes European and Japanese policies from those of United States discussed in chapter 13, is the absence of controls on exports of advanced civilian technologies and equipment to developing nations generally, or the Middle East specifically. Outside the Coordinating Committee (CoCom), the multilateral controls on exports to communist nations, these nations have few official disincentives for nonmilitary exports. Japan's liberalized foreign exchange law, for example, requires only that investors notify the Bank of Japan when they make investments in the Middle East, unless the enterprise involves banking, fishing, or military production. Approval of plant exports is normally automatic if contracts are signed.[59]

Similarly, all German exports must be approved by the Federal Office of Commerce in Frankfurt-Eschborn, but few denials are made except for items on the CoCom list. All of these nations have special regulations on nuclear exports, but as discussed in chapter 9, there has been considerable variation in implementation. Nor do these nations have antiboycott policies similar to those of the United States.[60] Their comparatively vigorous trade promotion efforts and the absence of controls set the policies of these supplier countries in contrast to those of the United States.

The different policy approaches certainly reflect historic patterns of business-government relations in these nations, as well as variations in propensity of nations to play a great-power diplomatic role. Reflecting these differences, these nations have each developed expertise in particular types of technology trade. The

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[59] See "Japan's Plant Export Activities," *JEI Report*, No. 32A, Aug. 26, 1983, p. 3; *Look Japan*, Jan. 10, 1980, pp. 12-13.

[60] In 1979, U.K. Energy Secretary Tony Benn issued a statement effectively banning sales of North Sea oil to Israel. This policy was challenged in court on the grounds that a 1975 agreement between the EEC and Israel prohibited any new restrictions on trade with Israel. See *Financial Times*, Dec. 3, 1983, p. 3.

French, for example, have through their state-led approach succeeded in putting together large "package contracts" involving many French firms, including public enterprises. This approach has encouraged French participation in large public works contracts.

Japan has emphasized plant exports, while West Germany exports capital equipment and training; in both cases, private sector firms play particularly important roles in technology trade and historical interrelationships of economic institutions (corporate groupings and close business-government relations in Japan, and the interaction of financial and corporate institutions in the FRG) have facilitated trade.

The British approach is distinguished by a clear separation of public and private institutions, and an absence of large consortia bidding that is more common among firms from nations where banks and corporations work more closely (Japan and West Germany).

The conclusion that must be drawn from this analysis is that there is no one national approach which is clearly superior. All of these nations remain important competitors in Middle East technology trade today and will continue to be so in the years ahead. Among the Western suppliers, French and British market shares declined slightly during the last decade, while only Japan decidedly increased its share.

There is no evidence to support the argument that government policies consistently determine patterns of technology trade. In some instances, such as the Japanese Government's support for large "national projects" or French Government-led negotiations for large-scale contracts, governments have certainly helped to foster specific projects, but these cases are the exceptions rather than the rule.

On the other hand, all of these nations have developed policies supporting technology trade which are assets to exporting firms. The dollar value of direct export subsidies is, in this regard, perhaps less important than the organizational resources which governments have at their disposal for putting buyers and sellers in contact, for coordinating public-private sector activities in technology trade, for combining commercial and "philanthropic" aspects of development assistance.

Firms have generally been the major actors in technology trade: the strengths and weaknesses of particular firms and industries generally are more critical in winning a sale than the actions of government policymakers. However, in some cases these actors are one and the same (e.g., nationalized telecommunications firms).

With the exception of Britain, all of these countries have during the past decade allowed economic and energy concerns to rise to the fore in their policies toward the Middle East. Their ability to put together large consortia "packages" has been an asset; in the decade ahead the expertise of smaller and more specialized technology exporters may become more important in less rapidly growing Middle East markets. Thus, the newly industrializing countries as well as smaller firms in West Europe may expand their market shares in specialized niches. West German firms appear particularly well placed to take advantage of a growing demand for specialized technical assistance. Japanese firms, particularly the corporate groups associated with trading companies, are also in a good position to expand exports in a number of areas such as telecommunications equipment.

Governments play important roles in setting the overall foreign policy context within which technology trade occurs. The fact that historical and colonial ties are still reflected in technology trade relations indicates the importance of government policies at the highest level. In few instances have specific trade promotional or financing programs solely determined the competitive success of firms, but they have provided significant support for exporting firms. The environment of cooperative business-government relations characteristic of some of these nations, combined with the comparative absence of controls, and the general receptivity to coupling commercial interests with assistance and politics set the policies of other Western suppliers in contrast to those of the United States.

II: SOVIET BLOC SUPPLIER COUNTRIES

As a group, the Soviet bloc countries, including the U.S.S.R. and Eastern Europe, have not been particularly successful in expanding their share of commercial exports to the Middle East region. In contrast to the Western supplier nations which are important competitors with U.S. firms and organizations in Middle East markets, the role of the Soviet bloc countries—particularly the Soviet Union—is particularly important to military and strategic issues in U.S. policy.

The remainder of this chapter identifies major trends in Soviet bloc economic interactions with the Middle East, highlights policies affecting technology transfer to the region, explains why these nations have played a comparatively limited role in civilian technology trade with the region, and looks ahead to future prospects.

As in other areas of research on the U.S.S.R., it is difficult to assemble reliable data on Soviet bloc trade and policies. What is clear is that during the last decade, Soviet interactions with the Middle East have included considerable military assistance, while East European interactions have been concentrated more in commercial trade. Training, however, has been a key element in technology trade relations with the Middle East, both for the U.S.S.R. and Eastern Europe, and in both the military and civilian spheres.

There is little doubt that the ability of Soviet bloc countries to compete with Western suppliers in commercial technology trade remains limited, and will probably remain so during the next decade. However, there are indications that Soviet bloc policies towards encouraging technology trade have been strengthened in recent years, and some signs that Middle East countries may wish for a variety of reasons to expand economic relations with these countries. Therefore, despite the comparatively small role that these countries play in commercial technology trade with the Middle East, they represent another group of supplier countries whose actions are of importance to U.S. policies.

TRENDS IN SOVIET BLOC ECONOMIC INTERACTIONS WITH THE MIDDLE EAST

Military assistance has undoubtedly been a more important component of Soviet economic interaction with the Middle East than economic assistance and commercial trade. In contrast to East European military aid, which has been quite limited, Soviet military assistance remains high relative both to Soviet military aid to other parts of the world and to military aid from other suppliers. Between 1956 and 1979 the U.S.S.R. committed close to $35 billion in military aid to the Middle East and North Africa, or about three-fourths of all Soviet military aid to non-Communist developing countries worldwide.[61] In 1976-80 alone, Soviet arms transfers to the Middle East (including Libya and Algeria) were valued at $19.8 billion.[62] During the same period, U.S. arms transfers to the Middle East, including Israel, were valued at $14.2 billion (table 103).

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[61] Central Intelligence Agency, Washington, D.C., "Communist Aid Activities in Non-Communist Less Developed Countries, 1979 and 1954-79," Research Paper, 1980. This does not include additional military agreements totaling almost $3 billion with North Africa.

[62] United States Arms Control and Disarmament Agency, *World Military Expenditures and Arms Transfers 1971-80*, ACDA Publication 115, March 1983, pp. 117-119. Total Soviet arms transfers to developing nations not including the Warsaw Pact during the same period were $26.2 billion (in current dollars).

Table 103.—Soviet, U.S., and French Military Arms Transfers to the Middle East, 1976-80 (million U.S. dollars)

Supplier recipient	Total	United States	U.S.S.R.	France
Africa	21,500	825	11,300	2,400
Algeria	2,300	N	1,800	N
Libya	8,600	N	5,500	410
Middle East	38,600	14,200	12,500	3,500
Egypt	1,900	430	20	600
Iran	8,300	6,200	625	200
Iraq	7,800	N	5,000	950
Kuwait	800	390	50	130
Saudi Arabia	4,700	2,000	N	700
Syria	6,600	N	5,400	290
Israel	4,300	4,300	N	N
Jordan	1,000	725	N	280

N Indicates either none or negligible.

SOURCE: *World Military Expenditures and Arms Transfers, 1972-80*, ACDA, March 1983, pp. 117-120. The United States and France are the two largest Western suppliers of arms to the Middle East.

While the lion's share of Soviet military assistance to developing countries has consistently been directed to the Middle East, this assistance has been focused on a limited number of countries: Egypt until the early 1970's, and currently Syria, Iraq, Libya and to a lesser extent Algeria and Iran. In contrast to the pattern of Soviet economic relations which are heavily weighted toward military assistance, East European military assistance has been more limited and commercial trade relatively more important.

Although most economic interaction with the Middle East has been in the military arena, Soviet economic assistance to Middle East countries has not been insignificant. During the last 25 years, Soviet military assistance to the Middle East and North Africa has been twice to three times as large as economic assistance to these countries; this economic assistance, estimated at about $11 billion, 1954-79, was nonetheless substantial, and comprised about 60 percent of the total extended by the Soviet Union to non-Communist developing countries worldwide.[63] As with military assistance, East European economic assistance has been much smaller than that of the Soviet Union, and the recipients have included roughly the same group of countries.

In contrast to the decade of the 1960's, when Soviet bloc commercial trade with the Middle East grew to a level comparable to that of many individual Western countries, during the 1970's the Soviet bloc share of exports to the Middle East declined markedly. In 1970, Soviet exports to the Middle East were roughly comparable in value to those of West Germany, and exceeded those of Japan, France, and the United Kingdom. During the 1970's, moreover, Soviet bloc exports to the Middle East continued to rise. Indeed, Eastern Europe found in OPEC its fastest-growing foreign trade, 1970-78; and although Soviet bloc exports to developing countries made up only about 3 percent of total foreign trade in 1978, the OPEC countries accounted for about 40 percent of all East European trade with developing countries. More than 70 percent of Hungary's industrial exports, for example, have gone to the Middle East in recent years.[64]

This growth, however, was outpaced by a growth of Middle East trade with the West, and during the 1970's the Soviet bloc share of total trade with the Middle East became very small. Table 104 shows Soviet exports to

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[63] CIA, *Communist Aid Activities . . .*, op. cit., pp. 13, 14, 18-21, 24, and 28.

[64] See Ronald G. Oeschler and John A. Martens, "Eastern European Trade With OPEC: A Solution to Emerging Energy Problems?" in U.S. Congress, Joint Economic Committee, *East European Economic Assessment* (Washington, D.C.: 1981), p. 514. See also *Middle East Economic Digest*, Special on Hungary in the Middle East, May 18, 1984, p. 55.

Table 104.—Middle East Imports From Selected Western Countries and the U.S.S.R., 1970 and 1978
(millions U.S. dollars)

		Egypt	Iran	Algeria	Iraq	Saudi Arabia	Kuwait	Libya	Syria
United States	1970	77.0	326.0	61.1	22.2	140.4	61.6	107.8	11.1
	1978	1,131.8	3,678.2	373.3	316.2	4,295.4	725.5	422.8	133.7
U.S.S.R.	1970	362.9	187.6	69.4	65.9	6.0	10.8	14.3	46.4
	1978	216.9	636.1	129.8	990.3	11.9	53.8	76.1	192.9
Japan	1970	12.4	178.8	20.2	15.9	83.8	94.4	31.4	16.1
	1978	400.3	2,691.1	729.3	951.5	3,254.3	774.1	353.7	88.2
France	1970	63.5	67.3	562.4	35.1	29.2	32.5	42.4	18.6
	1978	553.8	889.1	1,530.6	502.4	875.0	210.2	536.1	271.4
West Germany	1970	122.3	321.6	99.0	19.2	65.0	42.2	45.8	23.4
	1978	674.5	3,380.7	1,275.2	802.0	2,078.8	346.9	821.9	262.8
Italy	1970	64.8	82.5	93.6	15.4	34.6	25.9	133.6	20.9
	1978	407.9	1,068.6	949.2	323.5	1,466.8	287.9	1,306.5	237.6
United Kingdom	1970	44.4	154.9	40.2	55.4	78.1	70.1	55.4	14.2
	1978	393.8	1,428.7	231.1	415.2	1,505.3	636.9	410.9	110.8

SOURCES: Data for the United States, Japan, and France: *U.N. Supplement to World Trade Annual: Trade of Industrial Countries With the Developing Countries and Eastern Europe* (New York: Walker & Co., 1979). Data for the U.S.S.R. from the Central Intelligence Agency, computerized data, compiled from official Soviet foreign trade handbooks for each respective year.

the Middle East as compared to those of selected Western nations in the 1970's. Whereas the total volume of Soviet and East European annual exports to the Middle East almost quadrupled in 1970-78, the volume of annual exports from the West grew almost twelvefold. By 1978, the U.S.S.R. accounted for only 5 percent of the Middle East market.

Decline in the Soviet bloc's share of foreign trade with the Middle East countries was particularly steep not only in Egypt, but in Iraq, Syria, and Algeria. Iraq is the only country examined by OTA where imports from the Soviet Union have exceeded those of any one major Western supplier in recent years. But even here total exports from the U.S.S.R. were far exceeded by the combined total of exports from the West. (In 1978, Soviet exports to Iraq were estimated at $603 million, as opposed to $4.6 billion from the six major industrial countries.)[65] Trade with Saudi Arabia and Kuwait remains quite limited; trade with Syria, Algeria, and Iran (which remains East Europe's largest OPEC trading partner) has been larger but still far below the level of trade with Western countries.

Only a very small portion of Soviet bloc commercial exports to the Middle East have been technology-intensive products in the sectors examined by OTA. For the past decade, Soviet bloc exports to the Middle East have consisted mainly of primary products such as food, intermediate goods (chemicals, steel, cement, glass, textiles), services (including construction, training and medical services), and for the Soviet Union a growing portion of machinery and equipment. In all five technology sectors examined by OTA, imports from the West have far exceeded those from the Soviet bloc in the Middle East.[66]

In the five sectors selected by OTA, there is evidence that Soviet bloc countries have exported comparatively small volumes in the following subcategories: airplanes and helicopters, chemical technology including fertilizer plants, aerial communications systems, and medical construction services. The Soviet Union has comparatively strict control on exports of nuclear equipment, but has assisted in nuclear programs or planning over the years in Iraq, Libya, Syria, and Egypt.

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[65] Data for U.S.S.R. from CIA, Project Trader (computerized printouts compiled from official Soviet foreign trade handbooks). Data for industrialized countries from *UN Supplement to World Trade Annual: Trade of Industrial Countries With the Developing Countries and Eastern Europe* (New York: Walker & Co., 1979). It is unclear what proportion of Soviet exports may have been military related.

[66] Data do not permit conclusions about the degree to which Soviet exports are in technology-intensive sectors. Nearly half of total Soviet exports to Iraq in 1978, for example, were in machinery and equipment—a relatively technology-intensive export category. However, it is impossible to identify the composition of these exports, except to note that aerial communications facilities, geological survey equipment, and oil field equipment were included.

While overall exports in advanced-technology sectors examined by OTA are therefore quite low in comparison to those of the Western suppliers, Soviet bloc countries have managed to win contracts in some specialized areas: Czech participation in design of an airport in Iraq[67]; Romanian participation in petrochemical joint ventures in Iran[68]; Hungary's Medipex, along with West German and French companies, in a licensing agreement with Egyptian public sector pharmaceutical companies; the Hungarian telecommunications firm Budavox in a Libyan telephone cable network project.[69] In specialized areas, East European firms have developed considerable strength in advanced technologies—subsectors of aerospace being an example.[70]

The one area of civilian technology transfer where the Soviet bloc countries have maintained a strong presence is training. The number of Soviet bloc "economic technicians" serving in the Middle East and North Africa has far exceeded the number designated as "military technicians," the former numbering about 70,000 and the latter about 11,000 in 1981.[71] Of the total of economic technicians about half came from East European countries. Most of these technicians are located in the same group of countries with relatively strong economic interactions with the Soviet bloc—Libya, Iraq, Algeria, and Syria.

In addition, Soviet bloc countries educate many Middle Eastern students in technical fields in their own domestic schools. While the number of Middle Eastern students studying in the Soviet bloc is far less than those studying in the United States, they appear to be roughly comparable[72] to the numbers studying in individual major Western supplier nations.

In 1981, more than 23,000 students from the Middle East and North Africa were enrolled in Soviet bloc academic institutions, about 57 percent of whom were in the U.S.S.R.[73] Soviet bloc training of Middle Eastern students, both in the Middle East and in the Soviet bloc, thus remains central in Soviet interaction with Middle East countries.

To summarize, Soviet bloc economic interactions with the Middle East are strongly concentrated in a few countries. Interactions of the Soviet Union have been oriented toward the military sphere. For Eastern Europe, the Middle East appears more important as a market for commercial trade. Despite the fact that these countries have captured only a small share of civilian exports to the Middle East, these sales remain proportionally significant in Soviet bloc total trade with developing countries worldwide.

SOVIET BLOC POLICIES AFFECTING TECHNOLOGY TRADE

Soviet bloc policies regarding technology trade with the Middle East clearly reflect official state goals in the larger political sphere.

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[67] See Vladimir Broz, "Technical and Personnel Assistance in the Industrialization of Developing Countries," "Projects for Other Countries," and other information taken from scanning the Czechoslovak journal *Polytechna*. See also "Czechoslovak-Iranian Cooperation in Petrochemistry," Czechoslovakia's *Economic Digest*, September 1982, p. 5.

[68] Orah Cooper, "Soviet Economic Aid to the Third World," *Soviet Economy in a New Perspective*, compendium of papers submitted to the Joint Economic Committee, U.S. Congress, Washington, D.C., 1976, p. 295.

[69] Information taken from contract data listed in the *Middle East Economic Digest: Contract Data* for 1977-1981. See also "Patents for Hungarian Chemical Products," *Hungaro Press: Economic Information*, 1982, No. 20, pp. 176-177. For examples of other joint ventures with Hungary and West Germany in the Middle East, see "Reaching Third Markets Through Sicontact Co., Ltd." *Hungaro Press: Economic Information*, 1982, No. 24, pp. 5-6.

[70] "Czechs Gear for East Europe Sales," *Aviation Week and Space Technology*, June 11, 1979, p. 282.

[71] "Soviet and East European Aid to the Third World, 1981," U.S. Department of State, February 1983, pp. 2, 20. These figures include numbers serving in Algeria and Libya.

[72] Available U.N. data, however, include all students from Asia as well as from the Middle East. According to these data, in 1978 almost 22,000 students from Asia and the Middle East were studying in the U.S.S.R. The overall number of students from the Middle East and Asia was slightly more than in France (about 20,000), and almost the same number as in West Germany. The number studying in the United States, however, was almost seven times greater, at 147,280.

[73] U.S. Department of State, "Soviet and East European Aid. . ." op. cit., pp. 22-23. France ranks above the Soviet Union, and second to the United States in total enrollments of foreign students from all nations. See Institute of International Education, *Open Doors: 1981-1982*, 1983, p. 5. Enrollments in 1978 were 263,940 in the United States; 108,286 in France; and 62,942 in the U.S.S.R.

While it is accurate to describe the policymaking systems of the Soviet Union and Eastern Europe as comparatively centralized in official state institutions, foreign trade policymaking is a diverse and complex process, with competing interests and objectives evident at almost every stage.

This, in turn, has affected changes in policies affecting the extent and nature of Soviet bloc technology transfer to the Middle East. For the most part, Soviet policies have traditionally been shaped by political concerns, but economic objectives have apparently been gaining importance in the decisionmaking process. Individual East European states, on the other hand, tend to formulate policies which are generally complementary to but more commercially oriented than those of the U.S.S.R. Before discussing differences in policy objectives and actual policies, it is useful to first discuss the context in which technology transfer policies are made.

Institutions and Objectives

An examination of the institutions involved in Soviet trade and foreign policymaking reveals a striking variety of actors and considerable overlap in responsibility.[74] The overall framework for Soviet foreign and trade policymaking lies in the U.S.S.R.'s planning system. This system generates a series of plans designed to coordinate all economic activity in the U.S.S.R., including foreign trade.

Altogether, five plans are most critical for foreign trade, including: the export and import plans, plans for the the delivery of exports and imports between foreign trade organizations and the domestic economy, the plan for the delivery of equipment and materials for projects built abroad with Soviet technical participation (the "foreign aid plan"), the balance-of-payments plan, and the plan for economic integration with other Council for Mutual Economic Assistance (CMEA)[75] countries.

These plans, which are generally published only in very abbreviated form, govern economic interactions with foreign countries and with other CMEA members. A network of domestic Soviet and CMEA agencies are involved in their preparation and implementation, in a process which begins at the top of the Soviet governmental and party hierarchy. These plans are then reviewed and expanded by officials farther down the hierarchy, and finally coordinated again at the top, where final decisions are made.

In foreign trade policymaking, the Communist Party leadership and the Council of Ministers are the key actors, operating on information from the State Planning Commission, Gosplan, and the foreign trade and aid ministries. The Presidium of the Council of Ministers has two trade-related commissions to perform these tasks, and six main central agencies under the Council of Ministers play important roles in foreign trade planning.

Of the six agencies under the Council of Ministers, three have general planning duties: the State Planning Committee (Gosplan), the State Committee for Material and Technical Supply (Gossnab), and the State Committee for Science and Technology. As the main planning organ of the U.S.S.R., Gosplan's input is probably the most important; its role is mainly to coordinate the planning process for all of the other agencies.

Gosplan develops the methodological framework, assists in cost-benefit analysis used in foreign trade decisionmaking, and sets the initial plan targets which each ministry must use in compiling draft plans. Ultimately, therefore, Gosplan is responsible for allocating the most important products and resources, and for uniting the individual agency plans into one unified plan.

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[74] For a discussion of the evolution of foreign trade organizations and foreign trade policymaking in the U.S.S.R., see Glen Alden Smith, *Soviet Foreign Trade* (New York: Praeger, 1973), pp. 47-194; William Nelson Turpin, *Soviet Foreign Trade* (Lexington, Mass.: Lexington Boods, 1977); and Stephen Gardner, *Soviet Foreign Trade* (Boston: Kluwer-Nijhoff Publishing, 1983).

[75] Council for Mutual Economic Assistance countries include Bulgaria, Cuba, Czechoslovakia, East Germany, Hungary, Mongolia, Poland, Romania, the U.S.S.R., and Vietnam.

The State Committee for Material Technical Supply, or Gossnab, is responsible for allocating a broad range of commodities and for distributing all producers' goods. In terms of exports, Gossnab plays an important role in coordinating the supply of equipment for projects built abroad under the sponsorship of the State Committee for Foreign Economic Relations (GKES), the Soviet aid-giving body.

Finally, the State Committee for Science and Technology (SCST) formulates policies regarding research and development (R&D), and the introduction of new technologies. It is also responsible for buying and selling patents, as well as many of the international aspects of science and technology. The SCST negotiates and implements intergovernmental and private agreements on cooperation in science and technology and technology exchange with other countries through its organization Vneshtekhnika.

Also involved in foreign trade decisionmaking are three financial agencies under the Council of Ministers: the Ministry of Finance, the State Bank (Gosbank), and the State Price Committee. The Ministry of Finance monitors the effects of foreign trade on the state budget and develops the balance-of-payments plan. Gosbank is responsible for managing the system of foreign exchange control, for setting the exchange rate of the ruble and for the performance of the international banking service through Vneshtorgbank, its Bank for Foreign Trade, and through its interest in a number of banks such as the Moscow Narodny Bank of London. The State Price Committee participates in export pricing (as well as setting domestic prices on imported goods) and in debates on cost-benefit analysis of Soviet foreign trade.

In addition to the above planning institutions are a number of agencies which actually coordinate and carry out policies, including the Ministry of Foreign Trade and the State Committee for Foreign Economic Relations (GKES). Both of these institutions have some planning responsibilites, but the former also has exclusive right to sign contracts with foreigners and coordinates the agencies actually carrying out foreign trade. The latter concludes agreements with developing countries for economic and technical cooperation, administers foreign aid, and approves plant exports, including nuclear facilities.

In 1979, the U.S.S.R. established the Research Institute of Economic and Technical Cooperation under the GKES to improve the implementation of aid projects and to be responsible for the marketing and after-sales service of Soviet machinery and equipment provided under the aid program. There are also several individual ministries, enterprises and agencies which produce products and equipment for export—some of which are empowered to transact business directly with foreign countries.

Each of the above implementing organizations has associated with it a number of Foreign Trade Organizations (FTOs) which are so varied in their duties and structure that one observer has noted, " . . . the only thing they have in common is that they are all authorized to sign commercial contracts with foreign parties."[76] Of the 64 FTOs under the Ministry of Foreign Trade, most import or export a specific group of products; three are authorized to carry out border trade with particular countries, of which one, Vostokintorg, deals with countries in Asia and the East. In addition to the 11 FTOs subordinate to the GKES, there are seven others dealing in foreign trade under other ministries and organizations.

On paper, the division of responsibility appears clear, but in practice the lines between these ministries and FTO's are overlapping and vague. A given commodity, for example, may be exported by a particular FTO under the Ministry of Foreign Trade if it is sold conventionally, or by an FTO under GKES if it is sold under a governmental credit agreement. Licenses for technology transfer may be traded by Litsenzintorg, an FTO under the Ministry of Foreign Trade, or Vneshteknika, under the SCST, or by other FTOs depending on the type of equipment sale associated with the license.

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[76] Stephen Gardner, *Soviet Foreign Trade*, op. cit.

Other ministries, such as the Ministry of Foreign Affairs, not directly responsible for trade affect it, nevertheless, through their definition of overall relations with particular countries, including scientific and cultural cooperation. The Academy of Sciences, through its research institutes and laboratories in the Soviet Union and through its liaison with foreign academies of science, is involved in exchange of scientific information.

While Soviet trade with the Middle East is undoubtedly shaped by a variety of economic, political and other concerns, political objectives have traditionally been most central. Foreign trade in general is considered to be less important to the U.S.S.R. than to Western countries, and trade has generally comprised a relatively small part of GNP—less than 8 percent in 1975.[77] Where more extensive foreign trade has developed, however, the objectives have tended to be largely political in nature.

This was particularly true in the 1960's: Soviet leaders saw in their construction of the Aswan Dam, for example, an opportunity to promote political ties with Egypt. Premier Nikita Khrushchev himself noted: "By building the dam we would be winning the priceless prize of the Egyptian people's trust and gratitude. And not just the trust of the Egyptian people . . . but of all the other underdeveloped countries . . . Furthermore, we knew that strengthening the Arab countries meant weakening the camp of our enemies."[78]

Experts debate the precise political aims of the Soviet Union in the Middle East, but these goals can be generally described as increasing Soviet influence in the region and, as a corollary, diminishing that of the West. Whether the motivation is external expansion or protection of borders, and whether the means are primarily military or less direct methods, trade is viewed as an instrument of overall foreign policy.

In recent years, however, economic considerations have risen in importance, illustrated by the declining share of economic assistance in Soviet interactions with the Middle East, the Soviet shift to expansion of hard-currency exports, the increased stringency of terms of trade, changes in Soviet choices of aid recipients, greater Soviet marketing efforts in the Middle East, and growing emphasis on "mutual economic benefit" in Soviet trade relations with developing countries as a whole.[79]

Economic goals have included creating and sustaining markets for Soviet goods while simultaneously gaining access to raw materials, fuel and consumer goods, displacing Western markets, and encouraging long-term economic relations with the U.S.S.R. Thus, while Soviet interactions with the Middle East remain characterized by a preponderance of military assistance, commercial considerations have increasingly come to the fore.

Within this general set of economic and political objectives, however, substantial debate has been documented in more specific policy areas which also affect technology transfer to the Middle East. While it is often difficult for Western observers to identify the extent of rivalries and debates, or to assess their effect on specific decisions in the U.S.S.R., as is the case in any large bureaucracy, individual and organizational interests vary.

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[77] This compares to about 13.4 percent for the United States in the same year. See Robert Donaldson, "The Second World, the Third World and the New International Economic Order," *The Soviet Union in the Third World* (Boulder, Colo.: Westview Press, 1981), p. 364.

[78] Quoted in Stephen Gardener, op. cit., p. 28; taken from Nikita Khrushchev, *Krushchev Remembers* (Boston: Little Brown, 1970).

[79] In the 1950's and 1960's, settlement of payments was generally in nonconvertible currency. In contrast, in the 1970's about 75 percent of the U.S.S.R.'s trading partners were conducting their trade or settling outstanding balances with the U.S.S.R. in convertible currency. This was particularly the case for the oil-producing nations (Algeria, Iraq, and Libya) trading with the U.S.S.R. See Robert H. Donaldson, "The Second World, the Third World and the New International Economic Order," in *The Soviet Union in the Third World*, Robert H. Donaldson (ed.) (Boulder, Colo.: Westview Press, 1981), pp. 364-374.

To illustrate another point: in 1978,86 percent of Soviet aid commitments went to Morocco and Turkey, neither socialist nor strongly associated with anti-Western positions.

In terms of overall foreign policy in the Middle East, debates among Soviet policymakers have been documented concerning, for example, whether to support the Arab armies in 1967 or, several years later, whether to accord the PLO diplomatic status in Moscow.[80]

The immediate aftermath of the Iranian revolution in 1979 saw published debates in the Soviet press over how the new Islamic regime should be regarded in Soviet foreign policy. On one side were those who argued that communism must by definition be antagonistic toward religion, and thus argued that relations with the new Islamic state could not be justified on ideological grounds. On the other hand were those who said that the essence of the Islamic revolution had been anti-imperialist and anti-Western, and thus that Islam could be considered a positive force under certain conditions; proponents of this view believed that enhanced relations with Khomeini's Iran could be beneficial, and argued for a more ideologically flexible foreign policy toward the new regime.[81]

Debates among Soviet leaders have been documented concerning, for example, economic issues, such as the centralization of foreign trade planning and supplements for export manufacturers. Although there is little information on debates concerning trade with the Middle East, several Gosplan and Ministry leaders have reportedly viewed the high level of centralization in the Ministry of Foreign Trade as a barrier to trade expansion and an obstacle to enhanced prestige of other ministries and organizations.

Industrial producers have reportedly called for more contact with the world market if Soviet exports are to be competitive. Disagreements concerning export price supplements have also been documented between the Ministry of Trade, which supports the position that supplements are sufficient to cover additional costs demanded by export production, and other Soviet officials who argue that the supplements should be modified or increased.[82]

These debates underscore an important point in assessing Soviet technology transfer to the Middle East: despite the apparent uniformity of goals in Soviet foreign policy and foreign trade, political and economic objectives are sometimes subject to substantial debate and modification. These debates indicate that the economic concerns have become more important in Soviet trade with the Middle East, although trade continues to take place against the background of Soviet pursuit of broad political objectives.

In contrast to the Soviet Union, and especially in the 1970's, East European policy aims have generally been more economic than political in nature. The East European countries are by no means a homogeneous group, and each of them has different policies toward developing countries. In contrast to East Germany, which has most actively pursued a policy consistent with that of the Soviet Union, Romania, for example, has developed a more autonomous policy vis a vis the developing countries.[83]

Nonetheless, East European countries are heavily dependent on foreign trade, and their economies are dependent on energy imports (primarily from the Soviet Union at present) and on hard-currency requirements for imports from the West. East European countries have thus been more interested in building markets for their industrial and agricultural equipment exports. They have also established long-term agreements for supply of petroleum and raw materials from developing countries.

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[80] Ostensibly as a result of these debates, for example, Mr. Patolichev, Chairman of the Moscow Gorkom and a Central Committee member, was reassigned to become Ambassador to Denmark, and other Soviet leaders were similarly reassigned to other jobs and duties. See Karen Dawisha, *Soviet Foreign Policy Toward Egypt* (New York: St. Martin's Press, 1979).

[81] See Martha Olcott, "Soviet Islam and World Revolution," *World Politics*, July 1982, pp. 490-1 and 502-4. For some examples of part of these debates see E. M. Primakov, "Islam i protsessy obshchestvennogo razvitiia stran zarubezhnoga vostoka" (Islam and the Process of Social Development in the Countries of the Foreign East); *Voprosy filosofii* (Questions of Philosophy), No. 8, 1980, pp. 60-63; and G. Kerimov, "Pod zelenym znamenem Islama" (Under the Green Flag of Islam) *Kazakhstanskaya Pravda* (Kazakhstan Pravda), December 1980, p. 3; and M. T. Stepaniants, "Musul' manskoe vozrozhdenchestvo" (Muslim Revivalism), *Narody Azii i Afriki* (Peoples of Asia and Africa No. 3, 1983, pp. 20-29.

[82] S. Gardner, op. cit., p. 28.

[83] Michael Radu, *Eastern Europe and the Third World* (New York: Praeger, 1981), pp. 305, 307.

Some observers have emphasized East European energy requirements as an important factor in their dealings with Middle East countries, but it would appear that the Soviet Union may be able to cover most of their projected expanding energy requirements, albeit at higher prices than have been charged in the past to these countries for Soviet oil.[84] However, for individual East European states, such as Romania, oil imports from the Middle East are important.

THE RECORD OF SOVIET TECHNOLOGY TRANSFER POLICIES

During the past 30 years, Soviet trade policies with developing countries have undergone a shift toward more emphasis on economic considerations. Under Khrushchev, Soviet relations with developing countries were distinguished by big and showy projects, which were heavily subsidized but achieved uneven results. During the late 1950's and early 1960's, Moscow used concessionary financing (in the form of discounts from list prices and reduced interest rates estimated to average 2.5 percent with a 12-year repayment period).

By the mid-1960's, however, the disappointing results of many of these projects—delays, defaults and requests for postponements in repayments of Soviet debts, dissatisfaction with projects—as well as domestic economic reforms, generated a reevaluation in policy. With the fall of Khrushchev in the mid-1960's, a more financially conservative policy emerged which resulted in elimination of unallocated umbrella credits,[85] shorter repayment terms and higher interest rates, more emphasis on feasibility studies, and more attention, at least in stated policy, to the needs of the developing countries.

The trade policies of East European countries were also revised in tandem with those of the Soviet Union. In the 1960's, East European terms of aid and trade with developing countries reflected the concessionary flavor typical of Soviet policies. As a Polish trade official commented, " . . . to compete, the Communist countries, especially the smaller ones, have to provide the sweetener of credit. Without credit, the developing countries would buy from the West. This is important to Poland, since we now have to worry about securing markets for our own domestic industry. Our heavy industrial sector is overbuilt, and we are unable to sell all we produce within Poland or even to other Communist countries."[86]

Beginning in the late 1960's, the East European countries, strongly dependent on foreign trade, began to view aid to and trade with developing countries in more clearly economic terms. Many of these nations acknowledged their reduced capability to provide large credits; they shortened payment terms and eliminated subsidies.[87]

In the 1970's, therefore, Soviet and East European terms of trade became more similar to those offered by Western countries. Today, for example, both the U.S.S.R. and East European countries generally charge world market prices. Nevertheless, Soviet bloc countries continue to employ different vehicles, including payment in local currencies, tied aid and barter trade, in an attempt to expand their market shares in the developing world.

Barter trade, used here to include "countertrade," "buy-backs" and "compensation agreements," is an important feature of Soviet bloc trade. An early example was the agreement between Romania and Iran, which included Romanian export of a tractor plant in return for crude oil shipments from Iran.

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[84] *Technology and Soviet Energy Availability* (Washington, D.C.: U.S. Congress, Office of Technology Assessment, OTA-ISC-153, 1981), ch. 10, "The Soviet Bloc and World Energy Markets."

[85] "Unallocated umbrella credits" are untied credits—i.e., credit lines which are not allocated to any specific project, but under which projects would be established once the credit had been given.

[86] Quoted in Marshall Goldman, *Soviet Foreign Aid* (New York: Praeger, 1967), p. 186.

[87] Michael Radu, op. cit., pp. 94, 171-173, and 333-343.

Such agreements begun under the Shah continue today.[88] Similarly, Poland is building 20 major industrial facilities in Iraq, employing 2,500 workers, and will in turn be supplied with oil.[89]

In addition to barter trade, joint ventures and specialization increasingly characterize trade between East European and developing countries. In October 1982, a working group was formed within the CMEA to promote joint marketing of turnkey projects in third countries in order to reduce duplication of efforts by East European countries and improve their ability to offer more comprehensive packages for development projects.[90] These examples illustrate the growing commercial orientation of foreign trade policies of Soviet bloc countries.

During the 1970's, several East European countries also made administrative and organizational shifts designed to increase trade through promotion of market forces and participation of private interests. Perhaps the most flexible system of foreign trade emerged in Hungary. Changes have included allowing large Hungarian manufacturing firms to trade directly with foreign firms and companies, and introducing an element of competition among FTOs and in export financing. While foreign trade is still a Hungarian state monopoly under the Foreign Trade Ministry, more than 150 companies now have the right to trade directly with foreign partners—bypassing the FTOs. Manufacturing firms that do trade through FTOs now have the freedom to shop around among the more than 40 FTOs. In addition, a number of Hungarian companies have established joint ventures or foreign offices, such as one established to promote trade with the Gulf States.[91]

It would appear that, in official policy rhetoric at least, technology transfer has become increasingly emphasized in these overall foreign trade policies, but in very general terms. One Soviet writer—L. Zevin, of the U.S.S.R. Academy of Sciences—has written that scientific and technical relations are now regarded as a distinct and increasingly important category of Soviet foreign policymaking.[92]

In official statements, two themes stand out: that technology transfer requires a comprehensive reordering of the recipient's social and economic infrastructure in order to promote full utilization, and that a global restructuring along the lines of the New International Economic Order is necessary.

With regard to the first point, Soviet emphasis on comprehensive technology transfer, adapted to local conditions and fostering nationwide economic development, is contrasted with the approach taken by Western countries, which is characterized as fragmented and leading to the continuing dependence of recipients. Manpower training is stressed as important for the growth of scientific and technological potential in the recipient country and the development of production. Intergovernmental agreements on science, technology and cultural cooperation are viewed as the "most suitable organizational and legal framework" for technology transfers.[93] With regard to the second theme, Moscow has supported the concept of an international code governing technology transfer, in order to "eliminate the economic barriers created by transnational corporations to the social and economic progress of developing governments."[94]

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[88] "Romania Barters with Third World Partners," *South*, April 1982, p. 22. See also Pompiliu Verzariu, *Countertrade Practices in East Europe, the Soviet Union and China* (Washington, D.C.: U.S. Department of Commerce, April 1980).

[89] Michael Radu, op. cit., p. 311.

[90] "East European Contracts: Comecon Pines West," *Financial Times*, Nov. 29, 1982.

[91] Information on Hungarian trade reorganization comes primarily from the *Financial Times*, May 10, 1983, pp. I-IV.

[92] L. Zevin, "An Integrated Approach to Technology Transfer: Soviet Cooperation With Developing Countries," *Impact of Science on Society*, vol. 28, No. 2, Moscow: April-June 1978, pp. 183-191. Several other articles in the Soviet press have dealt with this theme. See, for example, P. Khoinik, "Slozhnye problemy torgovliirazvitiia " (Complex Problems of Trade and Development), *Mirovaia Ekonomika i Mezhdunarodnye Otnosheniia (M.E.M.O.)*, (World Economics and International Relations) May 1982, pp. 40-50; I. Egorov, Vneshneekonomiccheskaiia strategiia razvivaiushchikhsia gosudarstv" (The Foreign-Economic Strategy of Developing Governments), *M.E.M.O.*, May 1982, pp. 154-55; I. D'iakova, "Razvivaiushchiesia Strany Azii—Eksportery Tekhnologii" (Developing Countries of Asia—Exporters of Technology), *Azia i Afrika Segodnia* (Asia and Africa Today), No. 12, 1981, pp. 35-36; and A. Tkachenko, "Malye kompanii: Ekspansiia v razvivaiushchiesia strany" (Small Companies: Expansion to Developing Countries), *Azia i Afrika Segodnia*, No. 7, 1982, pp. 33-35.

[93] Ibid., p. 187. See also "Razvititie otnoshenii sotsialisticheskikh stran c pazvivaiushchimicia stranami v oblasti peredachi tekhnologii" (Development of Relations of the Socialist Countries with Developing Countries in the Sphere of Technology Transfer), *Vneshnaia Torgovlia* (Foreign Trade), vol. 3, 1983, pp. 25-31.

Discussions of technology transfer in the East European literature echo these themes. According to one East German scholar, technology transfer should be a component of the development plans of recipient countries, and socialist countries are particularly suited to transfer to technology because of their central planning and long-term strategies, and because they are prepared to export "labor-consuming" technologies.[95] Among the East European countries, Romania has been the most vocal advocate of a New International Economic Order.

There is evidence to suggest that Soviet bloc countries are now emphasizing technology transfer through a variety of channels such as sale of patents and licenses, consultant services in the field of economic planning and management, education and training, and building of research and design institutes. In contrast to the pattern of earlier years, where technology transfers from the Soviet bloc were associated primarily with equipment deliveries in conjunction with large-scale projects, there is a broader perspective on international technology transfer today.[96]

Among the varied channels of technology transfer currently considered as appropriate, stress on manpower training represents a continuation of past trends. Technical cooperation at the individual level is promoted through scientific conferences where representatives from the U.S.S.R. meet those from developing nations, through joint research projects and exchange of scientific publications. A variety of mechanisms have been used, such as on-the-job training in Soviet projects, Soviet personnel teaching in local schools, and scholarships for study in the Soviet bloc.

In all of these training programs, stress is laid on "mass training" of developing-country personnel in sectors most critical to economic development through group study methods. This emphasis on training in Soviet programs may be interpreted as intended to further economic and political aims by propagating Soviet ideology among local populations, and to ensure absorption of technologies exported, or as a method of tying operation of facilities over the long term to Soviet equipment and methods.

To summarize, Soviet bloc countries have developed a general approach which lays considerable stress on technology transfer as a part of foreign policy. For the Soviet Union, technology transfer is in rhetoric at least viewed as an instrument for furthering political aims of building alliances with developing nations. Training has been and continues to be a central feature of this approach. (Soviet policies dealing with nuclear technology exports, which have been comparatively stringent in years past, are discussed more fully in ch. 9.)

The strongly political orientation of Soviet bloc policies affecting technology transfer is clear, but East European countries have placed more emphasis on commercial aspects—and these considerations have recently come more to the fore in Soviet policy as well. Nevertheless, the striking fact is that, despite strong official support for technology transfer, these nations have not been very successful in commercial technology trade.

EXPLANATION OF SOVIET BLOC PERFORMANCE

The pattern of limited Soviet bloc involvement in economic interaction with the Middle East requires explanation. A number of factors act to limit the extent of Soviet bloc exports, but other factors—albeit weaker in total effect—suggest that there is a potential for expansion of technology trade in the years ahead.

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[94] See V. A. Ml'kevish, "S. Sh. A.—Razviviaushchiesia strany: peredacha tekhnologii" (The USA and Developing Countries: Technology Transfer), *Vneshnaia Torgovlia*, vol. 3, 1983, pp. 46-47 for a review of a book by R. I. Zimenkov on American Technology Transfer.

[95] Jerzy Kleer and Lech Zacher, "Technology Transfer From the CMEA Countries to the Third World," research report prepared for the Austrian Institute for Economic Research, No. 56, November 1979, p. 3.

[96] Zevin, "An Integrated Approach . . . ," op. cit., pp. 187-188.

Perhaps the most obvious explanation for the limited role that Soviet bloc exports play in the Middle East market is the fact that Soviet civilian products are generally perceived to be inferior in quality of technology. During the last decade, many oil-producing nations of the Middle East have been in a position to purchase the best equipment available. The view that Soviet technology is inferior has been articulated by Middle East leaders themselves. Saddam Hussein, leader of Iraq, stated in 1982: "Take technology and expertise. Do these exist in the Soviet Union or in America? I will answer you. The technology we require exists in the United States, or in Europe and Japan."[97]

To be sure, the Soviets do export some advanced technology in sectors such as oil field equipment, hydropower, aerial communications and geological survey equipment—particularly military-related equipment. Indeed, they are considered to be among the most competitive suppliers of power equipment and desert irrigation in the world. However, in most of the sectors examined by OTA, Middle East nations have purchased primarily Western technology, although Soviet-made 440 MWe nuclear reactors may be exported to the Middle East in the future, as discussed in chapter 9.

Concerns about the quality of equipment and sophistication of technology extend to East European-made exports as well as Soviet. In specialized areas such as Hungarian exports of buses and pharmaceuticals, East European firms have carved out niches in foreign markets. But in many product sectors, it appears that East European products are on a par with those from other developing countries.[98] The East Europeans themselves have noted that their level of manufacturing sophistication is in many cases not noticeably higher than that of many of the developing countries. Nevertheless, the fact that Middle East markets make up anywhere from one-quarter to two-thirds of many East European countries' total exports to developing nations (although a minor share of total exports) indicates that these exports are at least significant for Soviet bloc countries.

The fact that a large amount of Eastern Europe's commercial exports are in military-related equipment, and that these exports are normally compatible with Soviet-made equipment, illustrates the linkage of East Europe's commercial trade to Soviet policies. Where the recipient is a country politically allied with the Soviet Union, the East Europeans may reap commercial gains—particularly in comparatively less technologically sophisticated conventional arms sales.[99] Similarly, the continuing growth of East European agricultural exports to Middle East nations during the last decade while finished manufactures exports declined in terms of share, corroborates statements that Soviet bloc technology is in many sectors generally not on a par with that of Western countries.[100]

Another factor inhibiting Soviet bloc trade with the Middle East is the rigidity in their trade and administrative systems. While Soviet literature points to long experience with planning as a key asset in technology transfer, as noted above, the fact is that in many instances bureaucratic red tape and overlapping responsibilities have resulted in delayed shipments and inability to change product lines in response to shifts in export market demand.

An interrelated problem is the tendency of East European countries to depend on trade with communist countries. This stress on the home market has resulted in weakness in worldwide marketing and a lack of flexibility in responding to changing conditions in the marketplace.[101] The comparative underdevelopment of Soviet bloc institutions carrying out trade with developing countries is perhaps the root cause of this inability to market and change production in line with shifts in demand abroad.

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[97] Quoted in K. Dawisha, "The U.S.S.R. and the Middle East: Superpower in Eclipse?" *Foreign Affairs*, winter 1982-83, p. 444. Similarly, in the same text, Syria's Minister of Information is reported to have stated that Soviet military machinery and equipment used by Syria in the war in Lebanon was inferior in quality to U.S. weaponry.

[98] K. Z. Poznanski, "New Dimension in International Trade: East-South Competition in the West," unpublished paper, Department of Economics, Cornell University, December 1982.

[99] U.S. Department of State, *Conventional Arms Transfers in the Third World*, Special Report No. 102, August 1982, p. 8.

[100] Oeschsler and Martens, op. cit., p. 531.

Finally, East European writers have also noted the comparative lack of historical economic interaction with the Middle East as a factor limiting their commercial interactions. In their view, since Western firms already dominate Middle East markets, East European firms must expend considerable efforts to gain a presence. Because most CMEA trade is carried on among socialist bloc countries, as noted above, this absence of historical ties with the Middle East is reinforced.

For the Soviet Union, however, the picture is somewhat different. As a major exporter to the Middle East during the 1960's, and with numerous personnel in the region, the Soviet Union has a longer and deeper history of relations. However, as the expulsion of Soviet advisors from Egypt illustrates, in some cases good will has not resulted.

Other factors act to stimulate increasing economic interaction with the Middle East, but to date these factors have been less salient than those mentioned above. To a certain extent, Middle East countries which previously purchased equipment from the Soviet bloc may find it necessary to continue purchases of spare parts. While requirements for spare parts present a stimulus for trade with the Soviet bloc, it must also be noted that countries such as Egypt have succeeded in producing their own parts at the Helwan (Egypt) factory for use in Soviet-built civilian and commercial aircraft. Using reverse engineering where design drawings are not available, the Egyptians have received high ratings for their organization, management and engineering quality at Helwan. Even in the case of military equipment, nations are often able to find suppliers in third countries.[102] Nevertheless, under normal conditions recipient countries may prefer to go to the original supplier for spare parts.

A second factor with the potential to stimulate trade is the cheapness of Soviet bloc goods, and the willingness of these supplier nations to engage in barter trade. During a period of reduced revenues from oil production, Middle East countries may find trade with Eastern bloc nations more attractive, particularly given the requirements of nations such as Romania for oil imports which might be provided in exchange for Soviet bloc goods. Similarly, for good economic reasons, Middle East nations may naturally diversify suppliers in order to gain better bargaining leverage. The economic benefits of diversification of suppliers are, however, not unlimited. By relying on too many suppliers, the costs of spare parts and difficulty in ensuring compatibility of systems may increase.

Finally, Middle East countries may wish to expand relations with the Soviet bloc for political reasons. While on the one hand the Soviet invasion of Afghanistan undoubtedly diminished Soviet standing with many Middle East nations, the war in Lebanon and the inability of the United States to mediate a lasting peace in the region which resolves the Palestinian question may have heightened impatience with U.S. leadership.

Debates about the need to include the Soviet Union in a Middle East peace settlement are accentuated by the rejection of the Israeli-Lebanese agreement. The fact that the Brezhnev peace plan was more congruent with the

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[101] Kleer and Zacher, op. cit., p. 14. These rigidities are reportedly less apparent in arms sales. One report notes: "The speed with which weapons, once ordered, can be delivered is an important factor in the Third World arms trade. As a consequence of the industrial capacity created to support the huge Soviet conventional force modernization program, Moscow has important advantages over all other arms-exporting nations . . . " See U.S. Department of State, op. cit., p. 8.

[102] When Iran was embargoed by the United States, it reportedly received spare parts from Israel, and Soviet systems were obtained from Libya, Syria, and North Korea. Iraq has received Soviet parts from Egypt. See, for example, "International Report," *Defense Electronics*, October 1982, p. 19, cited by Stephanie Neuman in "Third World Defense Industries," paper prepared for U.S. State Department, INR, May 1983.

Fez Plan proposed by the Arabs indicates a potential receptivity to Soviet positions. In July 1984 Egypt announced that formal relations with the Soviet Union would be restored. The participation of Saudi Foreign Minister Prince Saud in a seven-member Arab delegation to Moscow, and King Fahd's message to then Premier Yuri Andropov both marked unusual Saudi overtures toward the Soviet Union in 1983.[103] Egypt also signed a trade protocol with the U.S.S.R. and Iraq an economic and technical cooperation protocol in 1983. While there is some dispute concerning the significance of these developments, increased openness toward diplomatic relations with the U.S.S.R. could well have an impact on trade relations.

Interpretations of these interactions between Middle East countries and the Soviet Union differ. On the one hand, such overtures may be viewed as a means of applying pressure on the United States to modify its policies in the region, specifically as a sign of disappointment with U.S. peacemaking. On the other hand, some observers argue that for Middle East countries which have established relations with the United States, the opening of relations with the U.S.S.R. merely establishes formal interactions with the other superpower—a fact of normal diplomacy for most nations in the world. Neither interpretation clarifies implications for technology trade, but the latter would suggest less dramatic changes in interaction than the former.

THE FUTURE OF SOVIET BLOC ECONOMIC INTERACTION

Judging by the volume of Soviet bloc exports to the Middle East, the performance of these nations in commercial technology trade—particularly in the sectors examined by OTA—has been weak. The declining share of Soviet bloc commercial exports as compared to those of Western suppliers indicates that these nations have achieved only minimal success in civilian technology trade with the Middle East.

Considering the rather modest levels of expenditure in terms of aid disbursements to the Middle East, it could be argued that Soviet bloc countries nevertheless have benefited from economic interaction with the Middle East. Deliveries of crude oil and natural gas from Iran and Iraq have contributed to meeting Soviet bloc energy requirements, and there has been a net flow of hard currency to the U.S.S.R. from the Middle East.

While Middle East countries have often been dissatisfied with Soviet bloc development projects, the Soviet Union has gained recognition from a few strikingly visible projects such as the Aswan Dam in Egypt and the Euphrates Dam in Syria. The effects of training are more difficult to judge, but these include at the least hard currency earnings and presumably in some cases expanded influence on opinions and decisions.[104]

Thus, the argument can be made that for a rather modest investment considerable gain has accrued for the Soviet Union in particular from trade with some Middle East countries, even though Soviet influence, however defined, may remain limited.

Will Soviet bloc countries become more important suppliers of technology to the Middle East in the decade ahead? During the last decade, Middle East countries including even traditional trading partners of the Soviet bloc have increasingly turned to the West in technology trade. More recently, however, a few moderate Arab states have indicated a willingness to consider expanded political ties with the Soviet Union.

As discussed above, political as well as economic factors may stimulate a modest but limited expansion in trade with the Soviet bloc.

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[103] See, for example, "Ukaz sees Need for Soviet MidEast Role" in *Foreign Broadcast Information Service (FBIS) Daily Report, Middle East,* Jan. 20, 1983, p. C.1; "As-siyasah Interviews Crown Prince Abdallah," in *FBIS Daily Report: Middle East,* Mar. 23, 1983, p. C.1; and "Ghali on Tabah, Relations With Soviet Union," *FBIS Daily Report: Middle East,* Mar. 25, 1983, pp. D.1—D.3.

[104] CIA, "Communist Aid Activities . . . ," p. 9. By 1979, hard currency earnings from exports of technical services exceeded $100 million annually for the U.S.S.R.

There is, however, little indication that these countries will become significant suppliers across the board in technology trade, or in all the sectors examined by OTA. Middle East countries will probably continue to acquire advanced technology primarily from the West, unless the political and economic context changes dramatically. In specialized areas, East European and Soviet suppliers may expand sales in the region, but these countries will in all likelihood continue to play a limited and secondary role in civilian technology trade.

III: CONCLUSION: TRADE AND POLITICS IN SUPPLIER COUNTRY POLICIES

This examination of approaches to technology transfer taken by non-U.S. suppliers in the West and in the Soviet bloc reveals a unifying theme: those supplier countries which have exercised or aspired to exercise a leading political role in Middle East politics have in most cases placed less stress on commercial promotion as a matter of public policy than the other suppliers. This is certainly the case for Great Britain (a former great power in the region) and the Soviet Union. Both nations export civilian technology to the Middle East, but they have not in the last decade captured rapidly expanding shares of the Middle East market.

This is not to suggest that playing a leading political role necessarily requires de-emphasis on economic issues. Among the Western suppliers, the French Government has woven political and economic policies most closely together in an active state-led approach to the Middle East. While this combination has not resulted in a rapid expansion of French civilian technology trade, some see it as perhaps important in preventing a more precipitous decline in French share that might have otherwise occurred. Nor is it the case that countries playing leading political roles gain no economic benefits. All of the nations playing a role in high-level politics nevertheless derive economic benefits from significant arms sales in the region. In addition, strong political alliances between suppliers and recipients have in many cases coincided with strong trading relationships.

Some countries opting for a lower-profile diplomatic and political role—including Japan and West Germany in the West and East European nations such as Romania and Hungary—rapidly increased their exports to Middle East markets in the 1970's.[105] By eschewing a high-profile diplomatic role, these countries have in some cases concentrated their interactions with Middle East nations in the economic sphere. All of them—particularly Japan and Romania—import some oil from OPEC. These nations are also secondary but significant members of their respective Western and Eastern political alliances.

The extent to which politics set a context for supplier-recipient technology trade relations is illustrated by table 101, which indicates the concentration of economic interactions of the supplier nations with a comparatively limited group of Middle East nations, in contrast to comparatively wide-ranging trade relations of nations such as Japan and West Germany.

Among the supplier nations in both the East and the West, those that have allowed economic interests to come more to the fore in their foreign policies have developed technology trade relations with a wide spectrum of Middle East nations. However, it would be a mistake to conclude tht these nations completely shun political roles. West Europeans have argued that, by engaging in trade with Middle East nations not closely associated with the West, they keep the door open for communication and interaction, thus performing a role complementary to that of the United States. Periodic frictions with the alliance leader, as were noted during the past decade in U.S.-European discussions of energy policies, have sometimes ensued.

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[105] Between 1974 and 1978 Romanian exports to OPEC nations increased annually 35.5 percent, and Hungarian 32.7 percent. See Oechsler and Martens, p. 522.

Nor would it be accurate to conclude that simply by renouncing a high-profile political role a nation necessarily will reap commercial rewards or that governments, particularly in the West, through public policies strongly determine the competitive positions of nations' firms in foreign markets. As observed in part I, there is little evidence that any one approach to technology transfer is clearly superior.

The interplay of politics and economics in technology trade is complex. Economic gains and losses of different types are associated with various political sources. By bringing economics to the fore in foreign policy and by developing policies which support technology trade initiatives taken primarily by the private sector, many supplier governments have set a positive context for economic interaction with Middle East nations. Governments thus play important, but not determining, roles in affecting the pattern of technology trade by establishing the broad political context of relations (including military and development assistance programs in Middle East nations), and then by supporting (or impeding) specific technology trade initiatives taken primarily by the private sector.

CHAPTER 13

U.S. Policies Affecting Technology Trade and Transfer

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CHAPTER 13

U.S. Policies Affecting Technology Trade and Transfer

INTRODUCTION

The ongoing tension between policies that promote and policies that control technology trade and transfer is a distinguishing feature of official U.S. policies affecting technology trade with and transfer to the Middle East. In practice, policy decisions affecting technology transfer have reflected changing views about which of several goals should be maximized: promoting U.S. commercial interests, ensuring that technology transfers are consistent with American security and foreign policy aims, or fostering effective development assistance.

During most of the postwar period, U.S. technology trade with the Islamic countries of the Middle East was limited to the oil production sector. During the 1970's, as technology trade between the United States and these countries rapidly expanded, government policies sometimes promoted and at other times inhibited the growth of technology trade. On the one hand, the growing strategic importance of the region, concern with the security of Western energy supplies, and export opportunities offered by the growing Middle Eastern market for advanced technology imports, stimulated increasing American economic interaction with these nations. On the other hand, the close U.S. relationship with Israel and the growing resolve to reduce flows of technology to the Soviet bloc and to countries whose foreign policies run counter to those of the United States have stimulated policies aimed at controlling and reducing technology transfers. Compared to the policies of other Western supplier countries (discussed in ch. 12), U.S. policies during the last decade that affect technology transfer have been characterized by growing restrictions.

This chapter identifies competing policy goals and analyzes their effects on technology trade. The sections that follow deal in turn with the general pattern of economic interaction with the region, the overall U.S. foreign policy context, international commercial policies, development assistance policies, and military-strategic policies. A major theme is that competing interests at stake have been reflected in an ad hoc approach to U.S. policies. In addition, official policies have emphasized technology trade more than technology transfer.

The focus of the discussion is those policies which are most relevant to U.S. technology trade with the Middle East, rather than general policies affecting technology trade with all developing nations. Therefore, issues such as U.S. antiboycott policies are examined, while the U.N. debates over the "new international economic order" receive less attention.

U.S. ECONOMIC INTERACTIONS WITH THE MIDDLE EAST

COMMERCIAL TECHNOLOGY TRADE

During the past decade, the Middle East has been the fastest growing market for U.S. exports. By 1982, U.S. exports to 15 Islamic countries of the region amounted to almost $17 billion, about 8 percent of total U.S. worldwide exports. In that year more than 9 percent of U.S. exports went to the Middle East region (including Israel), and about 6.3 percent of total U.S. imports came from the region during the same year (see table 105). Almost half of U.S. exports to the Middle East have been in the form of machinery and equipment, while American exports of basic manufactures have been much less important. U.S. firms received Middle Eastern contracts valued at more than $6.6 billion in 1981 and $3.3 billion in 1982.[1]

U.S. imports from the Middle East have been primarily in the form of oil. In 1980, the United States imported about 15 percent of all Middle Eastern exports, valued at $36 billion.[2] The United States had throughout the decade a trade deficit with the Middle East and with the Organization of Petroleum Exporting Countries (OPEC), owing to the greater value of oil imports relative to the growing level of U.S. exports to the region. However, because of the slack oil market and reduced U.S. oil imports, the United States achieved in 1982, for the first time since 1973, a favorable balance of trade with oil-exporting nations of the Middle East collectively. By 1982, U.S. oil imports from members of the Organization of Arab Petroleum Exporting Countries (OAPEC) had fallen to less than half the amount imported in 1973.

Table 105.—U.S. Trade With the Middle East
(million dollars)

	Exports		Imports	
	Middle East	World	Middle East	World
1982	19.8 (9.3%)	212.2	16.2 (6.3%)	254.8
1981	18.3 (7.8%)	233.7	30.6 (11.2%)	273.3
1980	14.2 (6.6%)	220.7	35.1 (14.0%)	256.9
1976	10.5 (9.1%)	115.4	16.8 (12.7%)	132.4
1972	2.1 (4.2%)	49.7	1.0 (1.7%)	58.0

NOTE: Sixteen Middle Eastern nations included Algeria, Iran, Iraq, Kuwait, Libya, Oman, Qatar, Saudi Arabia, United Arab Emirates (UAE), Egypt, Israel, Jordan, Lebanon, Syria, North and South Yemen. (During 1982, U.S. exports to Israel were valued at $2.2 billion, and imports from Israel at $1.2 billion.)

SOURCE: International Monetary Fund, *Direction of Trade Statistics Yearbook*, 1983 and 1979.

U.S. direct investments in the Middle East have been limited and concentrated primarily in the petroleum sector. During the 1970's, when Middle Eastern governments assumed larger equity shares in oil companies such as ARAMCO, the United States experienced negative investment flows. But by the end of the decade, U.S. direct investment in the Middle East totaled about 1 percent of a total of $227 billion invested worldwide.[3] Middle East oil-producing nations have made relatively few direct foreign investments in Western firms, concentrating their funds instead in bank deposits, bonds, and other portfolio investments. (In 1981, direct investments in the United States by OPEC amounted to $3.5 billion, or about 4 percent of all foreign investments in the United States.) However, Middle Eastern holdings in U.S. bonds and deposits in banks were much more extensive, estimated at $70 billion in 1982.[4]

The product export, contract, and investment flows outlined above established the context for economic interaction between the United States and the Middle East. Three important themes, outlined more fully in chapter

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[1] See "Middle East Contracts: Directory and Analysis, 1982 Second Half" (London: *Middle East Economic Digest*, 1983), p. 9. In 1983, U.S. firms won $10 billion worth of contracts, but $4 billion were in Turkey and another $3.9 billion were in defense contracts in Saudi Arabia. See *Middle East Contracts: Directory and Analysis*, 1983, p. 11.

[2] International Monetary Fund, *Direction of Trade Statistics Yearbook, 1983* (Washington, D.C.: IMF, 1983).

[3] Data include Egypt, where U.S. direct investment totaled $1 billion in 1981. Department of Commerce, *Survey of Current Business*, August 1982.

[4] See R. David Belli, "Foreign Direct Investment in the United States; Highlights from the 1980 Benchmark Survey," *Survey of Current Business*, October 1983. See also "U.S.-Arab Trade" (*Middle East Economic Digest*, October 1982), p. 35.

4, are particularly relevant to technology trade and transfer. First, American technology trade with the Middle East has been increasingly in technical service areas. At the same time, U.S. product exports of machinery and equipment, particularly in subsectors such as aircraft and nonelectrical machinery, remain important. In 1981, 8 percent of all exports of U.S. engineering products (valued at $7.4 billion) went to the Middle East.[5] Quite striking was the large proportion of technical service contracts awarded to U.S. firms. During the 1978-82 period, U.S. firms won half of the $2 billion worth of technical service contracts awarded in the medical sector, a third of the equipment supply contracts, but less than 5 percent of the construction contracts in that sector. U.S. firms also played leading roles as project managers for large development efforts involving design, construction, staffing, and operations. American expertise in advanced technology, services (particularly management and technical services), and personnel training has been in demand in Middle Eastern markets.[6]

Table 106.—U.S. Shares in the Middle Eastern Market, 1970-82

Year	Percent
1970	18
1971	19
1982	19
1973	19
1974	21
1975	10
1976	21
1977	22
1978	18
1979	17
1980	14
1981	16
1982	18

NOTE: Data include total imports for 15 Islamic countries.

SOURCE: International Monetary Fund, *Direction of Trade Statistics Yearbooks,* 1982.

Secondly, although the overall market share of the United States in the Middle East has fluctuated during the past decade, in 1982 the U.S. share of exports to 15 Islamic countries remained about what it had been in 1970, about 18 percent of the total. Table 106 shows the consistently strong position of U.S. firms in Middle Eastern markets. (Japan, however, became a larger exporter to the region than the United States in 1980.) This same export strength was seen in the U.S. machinery and equipment exports, as discussed in chapter 4.

Finally, U.S. economic interactions are concentrated in a few Middle Eastern nations, with Saudi Arabia and Egypt being the most important export markets. In 1982, $11.8 billion in U.S. exports went to those two nations. The U.S. presence in Kuwaiti and Omani markets is also strong, as it was in Iran before the revolution. Patterns of trade thus strongly reflect political alliances. However, the United States has sometimes traded with nations, such as Libya, not closely aligned with U.S. policy positions. In 1980, about 40 percent of Libya's exports went to the United States, but Libyan imports from the United States made up less than 1 percent of the total.

ECONOMIC ASSISTANCE

U.S. economic assistance, including official concessional aid for development purposes (ODA) and other types of economic aid, plays a relatively minor role in technology transfer compared to the volume of exchange in the commercial marketplace. It is, nevertheless, critically important to some Middle Eastern nations. During the period 1946-81, almost one-third of all U.S. economic assistance granted worldwide went to nations in the Near East and South Asia region, and in 1981, 36 percent of the total went to the region.[7] Two nations, Egypt and Israel, today receive by far the largest share of U.S. economic assistance to the region. Economic and military assistance to Israel grew rapidly following the 1973 October war, and economic assistance to Egypt increased after the Camp David accords. In 1981, the United States provided Egypt with $1.1 billion in economic assistance and Israel with $764 million, together amounting to 66 percent of the $2.7 billion sent to the region. Table 107 indicates the importance of Egypt and Israel in U.S. economic assistance to the Middle East.[8]

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[5] United Nations, *Bulletin of Statistics on World Trade in Engineering Products,* 1981.

[6] According to one study, the United States lost its dominant market share in OPEC markets, in 4 of 14 high-technology export markets—chemicals, electrical power machinery, transistors, and scientific instruments. In other markets—aircraft, fertilizers, office machines, electrical measuring equipment—U.S. share increased between 1970 and 1978. For a more detailed discussion, see Raymond F. Mikesell and Mark G. Farah, *U.S. Export Competitiveness in Manufactures in Third World Markets,* CSIS Significant Issue Series, 1982, p. 52.

[7] See Agency for International Development, *U.S. Overseas Loans and Grants and Assistance from International Organizations,* July 1, 1945-Sept. 30, 1981, pp. 4, 7. Economic assistance includes loans and grants for AID programs, Food for Peace, the Peace Corps, Contributions to International Lending Organizations, and other economic programs. Economic Support Fund loans and grants administered by AID are included here.

A comparatively small percentage of U.S. economic assistance to the region is directed to programs supporting technology transfers in the industrial and service sectors examined by OTA. Most U.S. economic assistance to the Middle East involves grants and loans from the Economic Support Fund (ESF), which have amounted in recent years to $750 million annually for Egypt and about $1 billion per year for Israel, the largest program recipient. For Egypt, between one-third and one-half of the ESF funding has been devoted to the commodity import program (CIP), designed to alleviate balance-of-payments problems. (For Israel, funds are provided as a cash transfer and are not tied directly to development programs.) ESF funding is used primarily to support imports of raw materials, spare parts, and capital equipment to Egypt. While such imports include machinery and equipment, such as telecommunications equipment, most of these programs are not aimed specifically at promoting technology transfer.[9] Egypt also receives about $250 million in Public Law 480 funding, almost all of which has been used in recent years to support wheat imports from the United States.[10] A comparatively small share of U.S. economic assistance (about $100 million, for Egypt) has in recent years been explicitly earmarked for programs involving science and technology;[11] most of the programs support commodity imports, infrastructure development, and improvements in basic living standards.

Table 107.—U.S. Economic Assistance to the Middle East, 1981 and 1946-81

	1981		1946-81	
	Million dollars	Percent of world	Million dollars	Percent of world
Egypt	1,130	15	7,476	5.0
Israel	764	10	6,350	4.2
Bahrain	—		2	
Iran	—		766	
Iraq	—		45	
Jordan	10		1,433	
Lebanon	4		188	
Oman	1		8	
Saudi Arabia	—		31	
Syria	2		588	
PDR Yemen	—		4	
Yemen Arab Republic	21		143	
Total Near East and South Asia region	2,757	38	41,360	28
Total worldwide	7,305		148,872	
(Algeria)			203	

NOTE: Total for entire Near East and South Asia region includes in addition to the nations listed above: Afghanistan, Bangladesh, Bhutan, Cyprus, Greece, India, Kuwait, Nepal, Pakistan, Sri Lanka, and Turkey.

SOURCE: U.S. Agency for International Development, *U.S. Overseas Loans and Grants*, July 1, 1945—Sept. 30, 1981.

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[8] For fiscal year 1984, the U.S. Congress approved $750 million in ESF assistance to Egypt and $910 million in economic assistance to Israel. The House of Representatives approved $1.1 billion in ESF aid to Israel and $750 million in ESF aid to Egypt for fiscal year 1985.

[9] U.S. House of Representatives, Committee on Foreign Affairs, *U.S. Economic Assistance to Egypt and Sudan*, Dec. 30, 1982, p. 6. See also, General Accounting Office (GAO), *U.S. Assistance to the State of Israel*, GAO/IS-83-51, June 24, 1983, p. iii.

[10] Agency for International Development, *Congressional Presentation FY 1983, Annex IV, Near East*, 1983, p. 17.

[11] In fiscal year 1982 $35 million in new funding was provided for science and technology programs in Egypt. See House Committee on Science and Technology, *Science, Technology and American Diplomacy, 1983*, p. 94.

The U.S. Government also supports technology transfer through programs such as the U.S.-Saudi Joint Commission, which is paid for by the Saudi Arabian Government. Saudi Arabia has itself become a major donor nation. In 1981, it provided $5.6 billion (about 15 percent of the total provided by all nations worldwide) in official development assistance.[12] The U.S.-Saudi Joint Commission programs involved reimbursable expenditures totaling $700 million during the 1975-82 period, and about 80 percent of the funds for these programs were transferred to the U.S. private sector. While U.S.-Saudi Joint Commission programs are specifically directed at development of manpower, industry, science, and technology, they have also been important in promoting U.S. trade.[13] The U.S.-Saudi Joint Commission programs involve U.S. Government-supported technology transfers, but these projects are fully funded by the Saudi Government and therefore should be viewed quite differently from the economic assistance programs mentioned above.

Compared to other Western nations, the United States is still the major donor nation providing economic assistance to countries in the Middle East. The United States contributes about one-fifth of all official development assistance provided worldwide by the Organization for Economic Cooperation and Development (OECD) nations; U.S. economic assistance makes up a large share of the total received by Middle Eastern countries. In 1981, for example, Egypt received $1.7 billion in ODA commitments, of which the United States provided $1.1 billion[14] (see table 100, ch. 12). Compared to programs of other OECD nations, U.S. economic assistance to the Middle East has thus been substantial and it has been concentrated in support for Egypt and Israel.

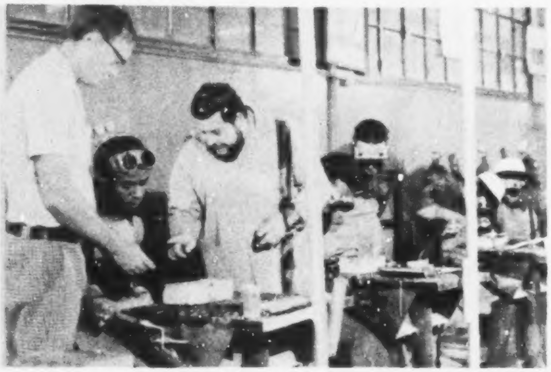

Photo credit: Saudi Arabian-United States Joint Commission on Economic Cooperation

The U.S. Department of Labor is working with the Saudi Arabian General Organization for Technical Education and Vocation Training to establish a nationwide vocational training system

MILITARY ASSISTANCE AND ARMS SALES

The United States has been a major supplier of military equipment and services to Middle Eastern nations. During the 1973-77 period, U.S. arms transfers to 15 Middle Eastern nations (including Israel) totaled $10.5 billion, compared to $7.5 billion for the Soviet Union.[15] These statistics include for the U.S. various types of military-related expenditures (construction, training, and management) not included for the Soviet Union or other suppliers, making it difficult to compare expenditures. In addition, there are problems with the values of the arms transfers, since offsets, commodity barter, and soft currency sales all may distort the values of transactions. During the 1977-81 period, however, the United States supplied Middle Eastern nations with more weapons than the Soviet Union in two categories—light armor and other military aircraft. In six other categories—surface-to-air missiles, subsonic combat aircraft, supersonic combat aircraft, major surface warships, artillery, and tanks—the Soviet Union provided more weapons.[16]

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[12] Organization for Economic Cooperation and Development, *Aid From OPEC Countries* (Paris: OECD, 1983), p. 15.

[13] General Accounting Office, *Status of U.S.-Saudi Arabian Joint Commission on Economic Cooperation*, GAO/ID-83-32, May 26, 1983, p. iii.

[14] Total ODA commitments include $1.5 billion in bilateral and $0.2 billion in multilateral aid. See, *Geographical Distribution of Financial Flows to Developing Countries* (Paris: OECD, 1982), p. 79.

[15] U.S. Arms Control and Disarmament Agency, *World Military Expenditures and Arms Transfers 1968-77* (Washington, D.C.: U.S. Government Printing Office, 1979), p. 156. Algeria is not included in the list, but did receive $470 million in arms transfers from the Soviet Union during the period.

U.S. military assistance, like economic assistance, has been directed mainly to Egypt and Israel, which respectively received $550 million and $1.4 billion in 1981, or together more than three-quarters of total U.S. military assistance to the Near East and South Asia region. This region, moreover, received three-quarters of U.S. military assistance worldwide during the same year (see table 108).

Both Egypt and Israel receive assistance in the form of financing for foreign military sales (FMS). Most of the repayments for this assistance have been forgiven; in 1983 Israel was allocated $750 million and Egypt $425 million in forgiven credits, out of total funding of $1.7 billion and $1.3 billion, respectively.[17]

In addition to official U.S. military assistance, commercial exports of military-related equipment licensed under the Arms Export Control Act amounted to almost $3.3 billion for shipments to the region between 1950 and 1981. This represented about one-quarter of total commercial military sales worldwide.[18]

Table 109 compares the value of various types of U.S. economic interactions in the Middle East for 1981.

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[16] See U.S. Department of State, *Conventional Arms Transfers in the Third World, 1972-81*, Special Report 102, August 1982, pp. 1, 14.

[17] General Accounting Office, p. 20. In fiscal year 1984, Israel was provided with $1.7 billion in military assistance (of which one-half was forgiven) and Egypt with $1.365 billion (of which $465 million was forgiven).

[18] Out of the total, about $1.6 billion went to Israel during the period. See Department of Defense, Security Assistance Agency, *Foreign Military Sales, Foreign Military Construction Sales and Military Assistance Facts*, September 1982, p. 32.

Table 108.—U.S. Military Assistance to the Middle East, 1981 and 1946-81

	1981		1946-81	
	Million dollars	Percent of world	Million dollars	Percent of world
Egypt	551	17	2,052	2
Israel	1,400	43	14,304	16
Bahrain	—		—	
Iran	—		1,405	
Iraq	—		50	
Jordan	44		1,039	
Lebanon	20		136	
Oman	25		50	
Saudi Arabia	—		292	
Syria	—		0	
PDR Yemen	—		—	
Yemen Arab Republic	1		3	
Total Near East and South Asia region	2,472	76	29,645	33
Total worldwide	3,244		90,715	

SOURCE: U.S. Agency for International Development, *U.S. Overseas Loans and Grants*, July 1, 1945—Sept. 30, 1981.

Table 109.—Comparison of U.S. Commercial Trade, Economic, and Military Assistance to the Middle East, 1981

Category	Value, 1981 (billion dollars)
Commercial exports	18.3
Contracts awarded	6.2
Economic assistance	1.9
Military assistance	2
Arms sales	3

NOTE: Middle Eastern region includes 15 Islamic nations and Israel. As discussed in ch. 2, there is some overlap among these categories.

SOURCE: Tables 105-108, ch. 13, and table 30, ch. 4 of this report.

THE FOREIGN POLICY CONTEXT

THE EVOLUTION OF U.S. FOREIGN POLICY

Technology transfer normally occurs in a larger context of foreign relations, and the patterns of commercial trade outlined above illustrate the influence of politics on trading relations, and vice versa. Because technology transfer involves more than simply exporting products, a deeper and longer-lasting relationship between the parties involved is required.

During the postwar period four themes have recurred in U.S. foreign policy toward the Middle East—securing oil supplies for Western nations, ensuring the security of Israel, limiting Soviet expansion in the region, and promoting peaceful economic and social development of the nations of the region. Over the years the problems surrounding these issues have changed, resulting in modifications to U.S. policy. The four themes remain, but debates continue about how best to define and achieve each type of foreign policy goal.

Until the end of World War II, U.S. political, military, and economic involvement in the Middle East was rather limited. During the first half of the 20th century, U.S. firms began oil exploration and production in the Middle East. The State Department, through its insistence that the British maintain an "open door" policy regarding Ottoman Empire oil holdings, helped American firms gain entry to Middle Eastern oil fields in the 1920's.[19] Palestine remained under the British mandate between 1919 and 1948, and it was not until the immediate postwar period that a clear U.S. policy emerged favoring the establishment of a Jewish state.[20]

The situation in the Middle East changed after World War II; the result was a gradually expanding U.S. role in the region. First, the Middle East oil fields boomed, fueling Western economic recovery. American firms in the ARAMCO group took the lead in Gulf oil development, encouraged by U.S. tax provisions that allowed the firms to count taxes paid to the Saudi Arabian government as credits against U.S. taxes. Secondly, concern with Soviet influence in the region grew as the British retreated from their former role as peacekeeper in the region. The rise of a nationalist Egyptian Government associated with the Soviet Union raised U.S. concerns about security in the region, particularly when President Nasser nationalized the Suez Canal in 1956. Third, United States ties to Israel grew during the postwar period. While no formal security pact was signed with Israel, the United States became that nation's largest arms supplier after 1967, when France cut off most arms supplies.[21]

The 1967 war was a turning point for U.S. policies toward the Middle East. The failure of the United States to negotiate a comprehensive peace settlement with the Soviet Union was followed by the emergence of joint European policies favoring U.N. Resolution 242. U.S. diplomatic efforts focused on terminating the fighting between Israel and Egypt. As Britain ended its military commitments "east of Suez," the Nixon Doctrine was announced. Accordingly, the United States increased provision of weapons and military training to nations such as Iran, which were viewed as important in regional security.

During the 1970's a number of important changes occurred in U.S. policies toward the Middle East. The 1973 Arab-Israeli war and the Arab embargo of oil shipments to nations supporting Israel demonstrated the growing power of Arab Middle Eastern nations. U.S. military assistance to Israel grew rapidly in this context. U.S. policies favoring concerted action by Western governments to coordinate their energy policies developed in the International Energy Agency eventually met with some success. At the same time, Western Europe and Japan also pursued independent policies aimed at building economic ties with the oil-producing nations. While U.S. firms participated in the Middle Eastern development boom fueled by growing oil revenues, American policymakers instituted restrictions of various types on military and civilian sales. (These restrictions are discussed more fully later.) In addition, the fall of the Shah of Iran and the Soviet invasion of Afghanistan led to a growing emphasis on military and strategic themes in U.S. policies that were embodied in the Carter Doctrine, which identified the Persian Gulf as an area strategically important to the United States. By the end of the decade, the United States established the Rapid Deployment Force and set up air and naval bases on the island of Diego Garcia.

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[19] Louis Turner, *Oil Companies in the International System* (London: George Allen and Unwin, 1978), p. 27.

[20] American policies were somewhat contradictory during the World War II period. In 1945 President Roosevelt assured Saudi King Abdul Aziz that no action hostile to the Arab people would be taken, a statement seen as diverging from his 1944 electoral campaign provision favoring a "Jewish commonwealth." After violence grew in Palestine between Arabs and Jews and proposals for partition stalled, the Truman administration recognized the new state of Israel minutes before the British mandate expired in 1948.

[21] Congressional Quarterly, *The Middle East* (Washington, D.C.: U.S. Government Printing Office, 1981), p. 11.

The 1970's not only brought stepped-up U.S. policy efforts to ensure the energy security of the West and the military defense of the Gulf States such as Saudi Arabia, but also extensive American diplomatic attempts to establish a lasting peace between Israel and its Arab neighbors. The accord between Israel and Egypt reached at Camp David in 1978 brought peace between the two nations but left open questions of the "final status" of the Gaza and West Bank areas occupied by Israel and home for many Palestinians. Egypt was, however, ostracized by Arab states and the Soviet Union, which had not participated in the negotiations. The United States pledged expanded aid to both Egypt and Israel and provided special security assurances to Israel in the event the treaty with Egypt fell apart.[22] Despite the success of Camp David, talks on the autonomy of the occupied territories stalled, and Egypt suspended discussions in 1980 after the Knesset of Israel declared Jerusalem to be the nation's "eternal and undivided capital."[23]

Following the Israeli invasion of Lebanon in 1982, the United States once again attempted to promote peace between Israel and the Arab world. The Reagan peace plan called for an "association" of the occupied territories with Jordan, a proposal which Jordan never fully embraced and one denounced by various Palestinian groups. Another set of negotiations were aimed at bringing withdrawal of foreign troops from Lebanon and beginning economic reconstruction in that nation.

The agreement for troop withdrawal reached between Lebanon and Israel in 1983 was, however, rejected by Syria, a nation receiving military assistance from the Soviet Union. As civil violence grew in Lebanon, U.S. Marines in the multinational peacekeeping force were redeployed offshore in 1984. The presence of U.S. troops in the multilateral peacekeeping force in Lebanon and the stationing of a U.S. aircraft carrier off the coast of Libya during Libya's invasion of Chad suggested the possibility of changes in the nature of U.S. military activities in the region. Finally, the prolonged and bitter war between Iran and Iraq raised concerns about the security of the Gulf States and the oil fields. In recent years, debates over U.S. policies toward the Middle East have centered around issues of arms sales, security commitments to friendly nations, and the nature of U.S. military activities.

IMPLICATIONS FOR TECHNOLOGY TRANSFER

Security and diplomacy have become the central themes in U.S. policies toward the Middle East during the 1970's, while commercial issues have remained secondary concerns. Nevertheless, commercial U.S. technology trade with the region expanded rapidly.

Following actions taken by the oil-producing nations to raise oil prices in the early 1970's, the demand for American equipment, technology, and services—both civilian and military—grew as the Middle Eastern development boom began and spread from the Gulf States to other Islamic countries in the region. These nations viewed science and technology as a way to catch up to the industrialized West and to reduce the technological gap between the Islamic nations and Israel.[24] Many businessmen and political observers saw growing U.S. commercial involvement with moderate Arab nations such as Saudi Arabia and Egypt in a positive light. They emphasized the contribution of technology trade and transfer to the promotion of special relationships with nations supplying oil and to countering Soviet influence in the region.

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[22] Congressional Quarterly, op. cit., p. 27.

[23] Ibid., p. 28.

Others, particularly some primarily concerned with the security of Israel, viewed growing commercial involvement with alarm. In their view, closer relations with the Arab states could endanger U.S. commitment to Israel. As a result, in the 1970's policies were developed to restrict U.S. commercial exports to the region for a variety of political and strategic reasons. American antiboycott policies, "foreign policy controls" used to restrict trade with nations supporting terrorist activities or violating human rights, and nuclear nonproliferation policies were all designed to restrict or oversee U.S. trade in order to further political or military goals. The fall of the Shah, moreover, heightened concerns about the risks of extensive U.S. involvement in nations of the region undertaking rapid economic development programs.

Thus, while American technology trade has grown along with U.S. military, strategic, and energy interests in the Middle East, technology trade has increasingly been regulated by official policies in order to achieve political or military goals. Those favoring export restrictions have viewed technology transfer with concern and have attempted to refine controls over exports of militarily critical technologies. In some cases, such as exports of sensitive nuclear technology, the controls have been instituted to further nonproliferation policies not specific to the Middle East. In other cases, such as foreign policy controls governing exports of commercial aircraft, or antiboycott policies, controls and regulations have been instituted to foster political aims in the Middle East. As discussed in chapter 12, no other major supplier nation has instituted such extensive controls over exports as has the United States. On the other hand, close U.S. relations with countries such as Saudi Arabia and Egypt have provided a context favorable to expanded U.S. technology trade there.

ENERGY POLICY AND TECHNOLOGY TRANSFER

During the decade of the 1970's, debates over U.S. energy policy focused on Middle Eastern oil. The central theme reverberating through all perspectives on U.S. energy problems was the goal of reducing oil imports. Policy perspectives evolved over time, each with different implications for technology transfer to the Middle East.

Energy Independence

Immediately following the 1973 price increases and oil embargo, energy independence became the central theme of government policies. "Project Independence" aimed to end all dependence on foreign energy by the end of the 1980's. Confrontation with OPEC was a major theme, particularly in the early part of the decade. In an effort to break what some called a producers' cartel, a number of proposals were made, including military action, oil import fees, food embargoes, and government oil purchasing.[25] As self-sufficiency receded as a feasible goal, emphasis gradually switched to enhancing domestic energy production, increasing flexibility in management of energy-related adjustments, and alternative energy development.

The general thrust of the energy independence perspective, particularly in its earliest vestiges, has been to limit technology trade and transfer with oil-producing nations. Confrontation with OPEC implies a general climate inhospitable to extended technology trade involvement in Middle Eastern oil-producing nations. In recent years, however, there has been less stress on confrontation with OPEC, especially when oil prices fell in the early 1980's. The general thrust of this perspective has been to reduce technology trade with the Middle Eastern oil producers.

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[24] See Foud Ajami, *The Arab Predicament* (Cambridge: Cambridge University Press, 1981), p. 195, for a discussion of the problems posed by Western technology. See also Seth P. Tillman, *The United States and the Middle East* (Bloomington, Ind.: Indiana University Press, 1982), pp. 21-22, for a discussion of the Arab reaction to Israel's superiority in science and technology.

[25] See, for example, House of Representatives, *Alternatives to Dealing With OPEC*, hearings before a Subcommittee of the Committee on Government Operations, June 20, 1979.

Allied Bargaining

The underlying rationale of allied bargaining, a second general perspective on U.S. energy policies, is that energy problems can best be solved jointly through coordination of policies with the Western nations in the International Energy Agency (IEA) and in summit conferences. Initially, proponents of allied bargaining saw it as a means to build a consumer bloc or cartel capable of countering OPEC. However, as Western Europe and Japan were more inclined to favor a wider, global energy dialog and because bilateral relations with producing nations continued to serve national goals, allied bargaining has been more narrowly focused in practice. Emergency oil sharing schemes, joint targets for stockpiles, and import reductions have been primary products of allied bargaining. At the same time, bilateral deals with producers and other new actors in the international oil market expanded in the latter part of the decade, limiting the coverage of allied policies.

Allied approaches to energy policy stimulate technology trade and cooperation among the Western consumers, particularly in development of energy technologies. In theory, an allied bargaining approach could contribute to a constructive dialog between oil producers and consumers. If such a dialog were successful in producing a comprehensive agreement on energy pricing and production in exchange for a Western commitment to provide technology and investment opportunities, the effect would be to stimulate multilateral technology transfers involving groups of suppliers and recipients. But while such a global bargain has long been advocated, in practice neither the producer nor the consumer blocs have been able to hold their members to even less stringent agreements. The members of each bloc have widely divergent short-term interests, exemplified by disputes between price hawks and doves in OPEC and by friction between the United States and Japan over spot market purchases of Iranian oil. Nevertheless, allied bargaining—even in its more limited IEA context—does serve to promote technology trade among participants.

Energy Security

A third approach has stressed energy security, implying a commitment to coordinate U.S. energy policies with military and security policies in order to reduce U.S. vulnerability to both short-term disruptions and long-term transitions in energy markets. Since the announcement of the Carter Doctrine in the late 1970's, programs such as the Rapid Deployment Force, the Strategic Petroleum Reserve, and emphasis on security of sea lanes have become central to discussions of U.S. energy policy. On the domestic scene, in order to promote energy security, the U.S. Government has been involved in promoting conservation, alternative energy development through price decontrols, and other measures. This vigorous approach to U.S. energy problems implies an active role for the Government, both domestically and internationally.

Emphasis on the security dimensions of energy policy has led to the fostering of "special relationships" with key oil-producing nations. Saudi Arabia, in particular, has been seen as a pivotal moderate nation in the Gulf. The energy security approach thus implies the stimulation of selective technology transfers to nations sharing mutual energy and security interests with those of the United States. At the heart of this approach is the notion that realistic bargains involving exchange of oil supply guarantees for technology exports can be struck. This approach demands considerable political leadership, since a vigorous domestic policy is also required.

Subordination of Energy Policy to Defense Policy.—Another approach to energy issues common in recent years has been to subordinate energy policy to defense policy. Proponents of this approach see international energy policy problems as fundamentally defense, and less frequently trade, issues. Instead of focusing on energy per se, proponents of this approach favor building strong bilateral and regional alliances in order to improve U.S. capability to respond to political developments that essentially determine energy politics at the international level. On the domestic scene, a deferral of energy choices to the private sector has been the major theme. In contrast to the energy security perspective, which places considerable burden on the U.S. Government to affect domestic energy markets, this approach implies withdrawal by the Government from all energy-related programs except those such as the Strategic Petroleum Reserve. By eschewing price and other types of intervention, proponents say, the Government can encourage market forces that spur economically efficient adjustments to changes in energy markets.

This last perspective accentuates the military and political dimensions of international energy policy beyond those of the energy security approach. Proponents tend to view technology transfer as a lever (sometimes as a counterbalance to the use of oil as a weapon) which can be used to achieve larger political and military goals. Like the energy security perspective, this approach serves to promote bilateral and selective technology transfers to specific Middle Eastern nations. It also stresses military technology transfers in conjunction with regional security arrangements.

Different perspectives on U.S. energy policy thus have diverging implications for technology transfer. During the last decade, each of the four perspectives has been advocated and has remained a part of the policy debate even after official directions have shifted to another approach. As a result, policymakers in the Middle East, as well as U.S. businessmen, have found it necessary to readjust frequently to new policy directions. In the early 1980's, U.S. oil imports, including imports from OAPEC, fell. As a result, energy policy issues receded in discussions of Middle East policy. Changes in the energy policy climate during the past decade have accentuated uncertainty for firms and organizations involved in technology trade with the Middle East.

COMMERCIAL POLICIES

In the United States, the private sector has played the leading role in promoting and financing international technology transfers. In contrast to the approaches taken by some other supplier governments discussed in chapter 12, the U.S. Government has not taken the initiative in organizing and negotiating on behalf of technology exporting firms.

Among U.S. commercial policies reviewed, only a few are designed, even in part, explicitly to promote technology transfer. Those include investment guarantee programs of the Overseas Private Investment Corporation and private voluntary efforts (e.g., Volunteers for International Technical Assistance). This section briefly evaluates the importance of various promotional programs, financing programs, and trade agreements for technology transfer to the Middle East.

Major attention is paid to the issue of export financing, in light of concerns that foreign supplier governments have developed more extensive programs in this area. Taken together with analysis of technology transfer in chapters 5-9 and policies of other supplier countries in chapter 12, this review of U.S. commercial policies indicates that, while U.S. Government financing and insurance programs have not been as extensive as those of some other supplier nations, such differences in supports to exports have only infrequently been key factors influencing competition for sales in the

Middle East in the sectors examined by OTA. (Upon occasion, attractive financing packages have helped suppliers to gain an edge in negotiations for sales of telecommunications, aircraft or nuclear technologies.) There are a number of reasons for this. First, many Middle Eastern countries have been in a position to finance technology imports themselves. (For capital-short countries such as Egypt, in contrast, financing has been a more central consideration.) Secondly, the subsidy element of export financing has been gradually reduced in recent years under the terms of the OECD Arrangement. Nevertheless, U.S. Government-supported extraordinary export support programs (involving mixed credits, guarantees, inflation and exchange insurance) remain less extensive than those of most other Western suppliers, and such programs may be increasingly important in the future.

PROMOTIONAL EXPORT PROGRAMS

Representation of Business

In the United States, a small percentage of the Federal budget is devoted to export promotion programs.[26] U.S. official representation of business, at both high diplomatic and routine commercial service levels, has not been as extensive as that of other supplier nations, as discussed in chapter 10.

The Department of Commerce's International Trade Administration (ITA) has been the major locus of educational and promotional activities related to foreign exports, but few of these programs have been directly aimed to promote technology transfers or exports of technical services. ITA programs provide information for potential U.S. exporters, assist them in penetrating foreign markets, and increase the awareness of potential foreign buyers. Surveys of various Middle Eastern national markets and reports outlining export opportunities in particular sectors, such as medical services, are published regularly. In an unusual display of U.S. Government support, Secretary of Commerce Malcolm Baldrige led a U.S. trade mission to Saudi Arabia and Algeria in 1982. However, export promotion programs generally have not been given high priority in the United States, and instances of high-level economic diplomacy on behalf of the private sector have been comparatively rare. In contrast to the situation in Western Europe and Japan, during the postwar period relations between the U.S. Government and business have been more adversarial, with the emphasis in public policies on regulating business.

In 1980, a new Foreign Commercial Service (FCS) was created in the Department of Commerce, officially transferring responsibility for business representation from the Department of State. While improvements have been made in the commercial services provided both to U.S. exporters and to potential foreign buyers, problems remain. Not the least of these arise from division of responsibilities between the FCS and the State Department. Indeed, the transfer of positions has not yet been completed, and in some cases commercial staffs in U.S. embassies overseas reportedly lack the resources and autonomy required to carry out all their functions. One report found, for example, the FCS to be inadequate in Saudi Arabia.[27] U.S. Government representation of business interests overseas is undoubtedly complicated by the fact that the FCS is required to maintain neutrality, and therefore is restricted in pointing out the special expertise of particular U.S. firms when they are competing with other U.S. firms. Nor does the FCS officer normally possess extensive technical expertise required to enhance the technology transfer component of overseas business transactions.

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[26] According to one report, the United States has spent on export promotion programs less to promote manufactured goods exports than have Japan, the United Kingdom, Italy and France but more than have Canada and West Germany. See U.S. Senate, Committee on Banking, Housing, and Urban Affairs, Subcommittee on International Finance, *Export Policy, A Report*, February 1979. Unfortunately, no data are available clarifying *total* Government support for exports (including all State programs, export financing, and insurance costs.)

[27] General Accounting Office, *Problems Hamper Foreign Commercial Serive's Progress*, GAO/ID-83-10, October 18, 1982, p. 12.

Private Sector Programs

While official U.S. export promotion programs affect technology trade on the margins, the primary force in U.S. exports is the private sector itself. As mentioned earlier, there are many private sector firms and organizations involved in technology transfer. Cooperative efforts involving either groups of private sector firms or mechanisms for government-business cooperation in international technology trade have been less prominent than in some other Western supplier countries. Traditionally, U.S. antitrust law prohibited joint private sector export efforts that restrict competition in the United States. A new law on export trading companies was signed in 1982, permitting the expansion of joint export efforts through antitrust exemptions, an extension of coverage to exports in services, and the participation of banks through bank holding companies. It is too early to determine the impact of this legislation on technology trade with the Middle East. Proponents anticipate expansion in exports, but opponents note that the largest exporting firms have already extended the involvement of other firms through contracting practices. In 1980, for example, Boeing was the largest U.S. exporter: almost 3,000 U.S. firms received orders through Boeing, for a total value of $4 billion.[28]

Private sector organizations such as the U.S. Chamber of Commerce have been active worldwide. Other institutions supported by the private sector, such as the U.S.-Egyptian Business Council and the U.S. Business Roundtable in Saudi Arabia, provide and disseminate information about regional market conditions.

Private sector mechanisms also exist for encouraging technology transfer. One of the oldest is the International Executive Service Corps, a private nonprofit organization that sends retired American businessmen abroad to work on development projects requiring their specific expertise. This organization has as a primary goal the transfer of technology to developing countries, but its activities have also led to expanded exports for U.S. firms. About 36 percent of the foreign clients in the 500 or so projects carried out annually have purchased U.S. machinery or equipment. The number of projects undertaken has dropped, apparently due in part to the fact that other supplier countries offer similar programs at even lower costs.[29] Similarly, Volunteers in International Technical Assistance (VITA) is a private, nonprofit corporation that assists through correspondence individuals and small businesses in developing nations. More recently established, with support from the U.S. Government, is the U.S. Telecommunications Training Institute, which offers courses for managers and technical personnel from developing nations. Another notable example is Project HOPE, a private nonprofit organization devoted to health care education and technology transfers to the developing world. In Egypt, Project HOPE has conducted extensive teaching programs for health science professionals that include programs in biomedical engineering, nursing education, and scientific exchange. Such private sector efforts are important in promoting technology transfers to developing nations.

The Role of Small Business

The role of small business has been a point of controversy over the years in debates about U.S. export policy. Proponents of promotion programs for small businesses argue that such businesses could play a much larger export role. Small firms, however, have not been particularly prominent in technology trade with the Middle East.

In the late 1970's the Department of Commerce announced that export promotional programs would target small, new-to-market firms with high export potential.[30] During 1982 and 1983 about $3 million was provided (under the Small Business Expansion Act of 1980) to support exports by small businesses. Matching grants were given in organizations contacting small businesses, conducting seminars on exporting and trade missions, although few of these programs were aimed at the Middle East market specifically. In addition, the Small Business Administration was authorized under the same legislation to begin a new financial assistance program for small exporters. During fiscal year 1982, about $10 million in loans was given to small businesses to support their exports.[31] Beginning in 1984, the Export-Import Bank planned to set aside 6% of the Bank's lending authorizations to support small business exports.

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[28] Congressional Research Service, *Export Trading Companies*, op. cit., p. 4.

[29] Statement by Thomas S. Carroll, International Executive Service Corps (IESC), hearings before the House Committee on Foreign Affairs, *Role of Private Sector in Development Abroad*, Feb. 24 and 25, 1982, p. 152. IESC receives $5 million in support from AID, $5.3 million from its developing country clients, and $1.4 million from other sources.

It is difficult to assess the success of these programs, since information is not available concerning the record of small businesses that have come into contact with them. Such efforts are costly and time-consuming, and short-term programs are not likely to become self-sustaining.

Finally, the Export Trading Company Act of 1982 was expected to assist small exporters by permitting trading companies to handle legal, financial, shipping, and marketing matters often difficult for smaller firms operating in distant markets. Most Department of Commerce programs have assisted smaller firms that have already begun to export, and proposals for establishment of quotas for small business participation in overseas trade missions have been rejected on the grounds that programs should assist firms that are best in a position to export rather than merely fill quotas. In 1982, a new program was established under the auspices of the U.S.-Saudi Joint Commission to promote joint ventures among small and medium-sized firms from both nations. This program, which was slow in getting off the ground, represents a new role for the government as a matchmaker between U.S. and foreign firms.[32] Despite these programs, large corporations continue to be much more prominent in foreign markets than small firms.[33]

Tax Policy

For years, businesses operating in the Middle East and in other foreign markets complained that U.S. tax policies burdened American citizens working overseas. In 1981 the tax exclusion on incomes of Americans working abroad was increased to $75,000 per year, eliminating many of the complaints. The tax exclusion on income earned abroad is scheduled to increase to $95,000 by 1985.

Controversy surrounded the Domestic International Sales Corporation (DISC), which allowed U.S. firms to establish domestic corporations that served as channels for exports and were given favorable tax treatment. A large export subsidy was provided by the DISC after its creation in 1971, and DISC was criticized as a violation of GATT rules by Europeans. In 1984 Congress established a Foreign Sales Corporation (FSC) to replace the DISC.[34]

Two aspects of DISC are relevant to technology transfer. First, the DISC was set up to cover product and commodity exports, and these tax advantages were not available to exporters of technical services. Secondly, the major beneficiaries of DISC have been larger firms, such as those that export chemicals, machinery and equipment, and aircraft.[35] As table

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[30] U.S. Senate, Committee on Banking, Housing, and Urban Affairs, Subcommittee on International Finance, *Export Policy*, part 6, hearing, Apr. 5, 1978, pp. 210-211.

[31] General Accounting Office, *Efforts to Promote Exports by Small, Non-Exporting Manufacturers*, Jan. 18, 1983, pp. 2, 11.

[32] "Saudi Arabia, U.S. Establish Bilateral Working Group to Spur Joint Ventures," *U.S. Import Weekly*, Sept. 20, 1982.

[33] Congressional Research Service, *Export Trading Companies*, IB80044, Dec. 2, 1982, p. 1.

[34] Thomas Kwako, "International Tax Rules," in Gary Clyde Hufbauer (ed.), *U.S. International Economic Policy, 1981*, draft report (Washington, D.C.: Georgetown University Law Center, 1982), pp. 6-27. For a summary of legislation proposing the Foreign Sales Corporation, see "Administration's DISC Substitute Bill Introduced in Both House, Senate," *U.S. Import Weekly*, Aug. 9, 1983. See also Hobart Rowen, "The Great Tax Grab," *The Washington Post*, July 5, 1984, p. A21. The FSC will allow for a 16 percent tax exemption on the combined earnings of the FSC and the parent corporation. The estimated tax loss for the DISC since 1971 was $12 billion.

[35] Department of the Treasury, *The Operation and Effect of the Domestic International Sales Corporation Legislation*, 1980 Annual Report, pp. 7, 22, 27.

110 shows, the gross receipts of DISC firms in Middle Eastern markets were valued at more than $8 billion in 1979, out of $11 billion in total U.S. exports to 15 Islamic nations in the Middle East. These exports were concentrated in sales to Saudi Arabia and Iran. Exporters of machinery and equipment to the Middle East in particular have benefited from DISC. The new FSC does not cover service exports, nor is it likely that it will be used to a markedly greater degree by smaller firms.

Government Support for Financing Exports and Foreign Investments

The primary mechanisms of Government support for financing involve loans and grants for exports and insurance to reduce the risk of exports and foreign investments. In the United States, the Export-Import Bank and the Overseas Private Insurance Corporation are the two most important Government institutions involved in financing. These financing programs have never been fully reconciled with other aspects of U.S. international economic and foreign policy.[36] Export financing remains a controversial issue in the United States.

Table 110.—DISC-Related Exports[a] to the Middle East, 1979

Geographical destination	Number of returns	Gross receipts of DISC firms (million dollars)
Algeria	439	341
Libya	643	301
Egypt	1,003	494
Iran	1,790	2,529
Iraq	524	205
Kuwait	985	548
Qatar	392	68
Saudi Arabia	1,808	3,081
UAE	834	333
Israel	2,315	1,045
Other Middle East countries	1,797	591
Total Middle East (excluding Israel)	10,215	8,489
Total U.S. Middle Eastern exports		11,371
Total U.S. exports worldwide		182,025

[a] Manufactured and nonmanufactured products.

NOTE: Deferred taxes amounted to 1.1 percent of gross receipts in 1980.

SOURCE: Office of the Secretary of the Treasury, Office of Tax Analysis.

THE SUBSIDIES CONTROVERSY

On the one hand, some argue that the Government's role in promoting exports and in supporting U.S. investments abroad should be reduced. Opponents of export financing view Government support as a subsidy for business which is not necessary or appropriate. A central theme of this argument is that American taxpayers should not be asked to support business exports. Particularly in light of the leading role that the United States has taken in negotiations to reduce trade barriers worldwide, opponents view export subsidies as distorting international trade and thereby inhibiting necessary adjustments by U.S. firms. A variation on this argument would support U.S. Government involvement in areas that have been mutually agreed on as acceptable, such as Export-Import Bank loans, but severely limit others, such as mixed credits. A second argument is that in practice export financing assists a few of the Nation's largest industries and businesses, and therefore benefits are directed to a relatively small number of firms. Finally, some critics focus their attack on those programs promoting U.S. investments abroad, seeing them as ultimately contributing to foreign production capacity, and potential U.S. employment loss.

While the critics of export financing have played the major role in policy formation, proponents also make persuasive arguments. They argue that international trade does not really operate in a free market context and that since some other supplier countries have developed extensive export financing programs, the United States should to do likewise. In addition, the use of various indirect, domestic industrial policies by other supplier nations indicates their commitment to support industries in a variety of ways. Instead of seeing the benefits of expanded exports as accruing to a few large firms, the proponents point to the subcontracts awarded to smaller U.S. firms and to the resulting gains in balance of payments. Despite continuing disagreements about the value of exports directly attributable to export financing, proponents argue that the gains are substantial and benefit the entire economy. Proponents view international trade and technology transfer as essential for the continuing competitiveness of U.S. firms, and many of them argue that U.S. exports and investments abroad open up new markets and contribute revenues which American firms use for research and development (R&D) investments necessary to maintain their cutting edge in technology development.

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[36] Roger E. Shields and R. Craig Sonksen, *Government Financial Institutions in Support of U.S. Exports*, CSIS Significant Issues Series, vol. 2, No. 4 (Washington, D.C.: Georgetown University, 1982), p. 2.

Evaluation of these arguments centers around the comparability of U.S. financing programs to those abroad, and around the question of how much difference export financing makes in determining the competitive positions of firms. Export insurance, financing, and Government support for foreign investments are briefly reviewed with these questions in mind. These are, however, complex issues that cannot be treated fully here.

U.S. export financing programs compare with those abroad but generally have been less extensive. However, it should be remembered that only in a small number of instances, where capital costs are great and equipment and technology are similar, have export credits made the critical difference in winning contracts in the sectors examined by OTA in chapters 5-9. Sales of aircraft, nuclear reactors, and telecommunications to nations such as Egypt are thus the exceptions to the general rule. There is, however, little evidence of a clear relationship between the level of official credit subsidy and the export success of domestic firms.

THE U.S. EXPORT-IMPORT BANK

The major institutions providing insurance and guarantees to reduce risk to U.S. exporters are the Export-Import Bank and the Foreign Credit Insurance Corporation (FCIC), the latter being an association of 50 private insurance companies. The insurance and guarantees are used to support short-term transactions involving repayment terms of up to 180 days. The FCIC underwrites most commercial risks and the Export-Import Bank, most political risks. Coverage of up to 90 percent for commercial and 100 percent for political risks is provided. During 1981, the fees charged by these institutions were midway between those charged by France (at the high end of the scale for Western supplier nations) and those of Japan, at the low end.[37] Medium-term insurance coverage is also provided. During 1982 the U.S. Government provided insurance and

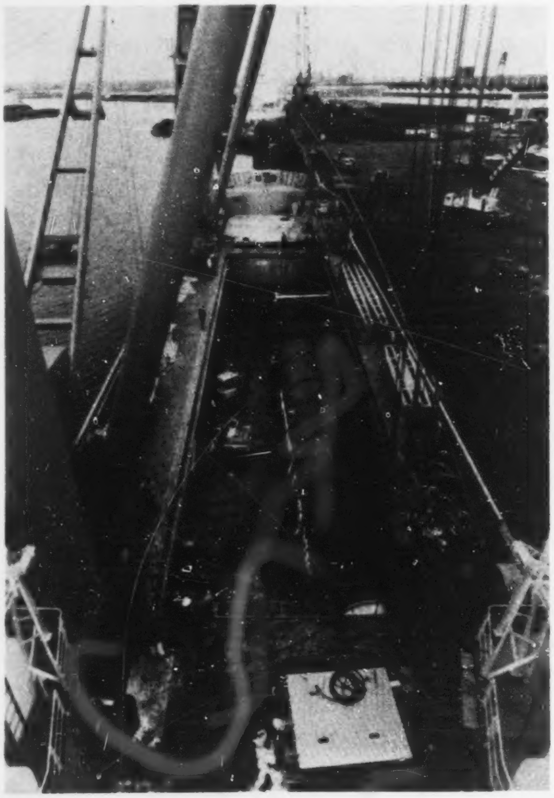

Photo credit: Export-Import Bank of the United States

High-technology heat exchangers, specified and procured by the Pullman Kellogg division of Pullman Incorporated, are loaded aboard a freighter for shipment to Algeria to be installed in a liquefied natural gas plant. The project was supported by the U.S. Export-Import Bank guarantee coverage amounting to $5.8 billion, which supported 5.3 percent of U.S. exports. (The value of U.S. insurance and guarantee programs has been slightly more than 10 percent of those of Japan.[38]) In the area of long-term loans and transactions, the United States does not offer many of the extraordinary export support programs such as inflation insurance, exchange rate risk, bond insurance, and foreign currency loans that most of the other major suppliers provide. Thus, the United States does not offer as wide a range of financing and insurance programs as do many major Western supplier countries.

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[37] This data and evalutations of the comparability of U.S. export financing programs that follow are taken from the *Report to the U.S. Congress on Export Credit Competition and the Export-Import Bank of the United States,* for the period Jan. 1, 1981 through Dec. 31, 1981, Export-Import Bank, December 1982, p. 19.

Export financing is used more extensively by some foreign governments than by the United States. Congress sets annual limits on the loans the Export-Import Bank can authorize. The Bank supports with loans a comparatively small percentage of total exports. In 1982 the bank authorized $3.1 billion in direct loans, supporting $4.7 billion in exports out of a total for the year of $212 billion.[39] In the area of long-term export credits, the level of subsidy provided by the United States has been lower than that provided by France or Great Britain, but above that provided by West Germany and Japan. Nominal and effective interest rates charged for these loans have also been higher than those in other supplier nations. Table 111 shows the level of subsidy and the effective interest rates for 1981 and 1982, as calculated by the Export-Import Bank.

During 1982, under the terms of the OECD Arrangement, the subsidy element was almost eliminated from export credits of major OECD nations except France. As a medium-term credit program was established by the U.S. Export-Import Bank in 1982, the bank programs became increasingly competitive with those of other major Western nations. On the other hand, the U.S. Export-Import Bank calculated that $400 million in U.S. exports were lost because of the expanded use of mixed credit programs abroad.

Table 111.—Comparison of Credit Subsidy and Interest Rates, 1981 and 1982

	Subsidy[a] (million dollars)		Interest rate[b]	
	1981	1982	1981	1982
France	466	250	8.61	11.75
West Germany	0	0	11.61	9.55
Japan	79	0	8.05	9.50
United Kingdom	382	0	8.75	11.80
United States	203	0	11.50	12.65

[a] Calculated as nominal cost of the life of a $1.0 billion 10-year credit. The amount of subsidy is that amount present when nominal export credit rates are compared to then-prevailing interest rates on government bonds of similar maturity in the same country and the relative attractiveness of a given interest rate to borrowers.

[b] Effective interest rate; estimated total cost of financing.

SOURCE: Export-Import Bank of the United States, *Report to the U.S. Congress on Export Credit Competition and the Export-Import Bank of the United States*, September 1983, pp. 5 and 8.

Despite the fact that U.S. export financing was less extensive and offered on terms less favorable than that offered by some major competitors during the past decade, U.S. firms have nevertheless been successful in major less-developed countries (LDC) export markets when competing against officially supported export credit agencies in France, West Germany, Japan, and Great Britain, according to the Export-Import Bank.[40] These same patterns prevailed in medium-term export financing, but the effective rates on loans in that case have been higher for U.S. Export-Import Bank credits. Thus, while U.S. export financing programs were generally not competitive in every respect with those offered by other major suppliers, some U.S. programs have recently been expanded, and there is no evidence that there is a clear relationship between the level of official credit subsidy and export success.

In the Middle East, export credits have been most important for sales in nations such as Egypt, where financing is a major problem. During its history, the Export-Import Bank of the United States has provided credits, guarantees and insurance supporting exports to the Africa and Middle East region totaling $17 billion, or less than 17 percent of its total authorizations to support exports worldwide. Credits and insurance for exports to Egypt during the period 1934-80 were valued at $413 million; Algeria, $2.1 billion; Iran, $2.3 billion; Iraq, $59 million; Israel, $1.9 billion; Kuwait, $643 million; and Saudi Arabia, $1.5 billion.[41] Table 112 shows Export-Import Bank authorizations for loans, guarantees, and insurance for fiscal year 1981. As discussed later in the context of mixed credits (those that combine concessional financing with official export credits), financing has been a key element in awards of Egyptian telecommunications contracts and (as discussed in ch. 9), in that nation's nuclear technology transfer plans.

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[38] Ibid., p. 66 and p. 77.

[39] Ibid., p. 76; also, Highlights of U.S. Trade for 1982. See also Export-Import Bank of the United States, *Report to the Congress*, 1983, pp. i, 4-13.

[40] Ibid., p. 12.

THE OVERSEAS PRIVATE INVESTMENT CORPORATION

In contrast to Government organizations which provide support for exports, the Overseas Private Investment Corporation (OPIC) is the major mechanism for Government assistance to American investors in developing nations. OPIC was set up in 1971 and is authorized to help finance only those projects that contribute to economic and social development in the host country and are at the same time consistent with U.S. balance of payments and employment goals. OPIC operates on a self-sustaining basis, but Congress reviews its operations annually and has directed OPIC to meet specific objectives. For example, Congress instructed OPIC to avoid support for investments that are restricted by host country performance requirements and could have adverse impacts on U.S. trade.[42] In 1978 Congress instructed OPIC to put priority on projects in the poorer developing countries, and in 1981 Congress raised the restriction on gross national product (GNP) per capita to $2,950 in 1979 dollars.

OPIC is unique as a U.S. Government instrument for promotion of overseas investment and technology transfer. Unlike the other commercial programs, OPIC funds investments in services and other ongoing operations that are more relevant to technology transfer than product exports. OPIC is a comparatively small agency; its significance is therefore as an instrument which could be used more extensively. Its loan and loan guarantee commitments were valued at $110 million in 1983.[43] During the 1979-83 period, OPIC supported 166 investment projects in 10 Near Eastern nations with almost $3 billion worth of insurance and $625,000 in project financing. During 1983 alone OPIC insurance supported $1.14 billion worth of U.S. investment in the region. OPIC offers investment insurance to protect U.S. investors against loss from war and insurrection, expropriation, civil strife, and inconvertibility of capital and profits. It also offers direct financial assistance and programs for U.S. investors. OPIC supports a program to provide management training and technology transfer and a UNIDO program that trains investment promotion officers from developing nations.

Table 112.—1981 Export-Import Bank Authorizations to Selected Middle East Nations
(million dollars)

Nation	1981 Authorization	1981 Total U.S. exports	1982 Authorization	1982 Total U.S. exports
Algeria	21	717	7.9	919
Egypt	64	2,159	66.7	2,875
Iran	0	300	0	122
Iraq	0	914	0	846
Israel	275	2,521	7.9	2,271
Kuwait	17	976	12.6	941
Saudi Arabia	36	7,327	75.4	9,026

SOURCE: Export Import Bank of the United States, *Fiscal 1981 Annual Report*, pp. 27-30; *Fiscal 1982 Annual Report*, pp. 31-34.

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[41] U.S. Export-Import Bank, *Cumulative Record by Country*, Feb. 12, 1934, to Sept. 30, 1980.

[42] Organization for Economic Cooperation and Development, *Investing in Developing Countries* (Paris: OECD, 1982), p. 106.

[43] Overseas Private Investment Corporation, *Development Report 1983*, p. 28.

Photo credit: Overseas Private Investment Corporation

Technology for recovery and recycling of key metals was introduced in Egypt by a U.S. firm in an OPIC-supported project. The project also accomplishes goals of eliminating hazardous wastes, and restoring land previously used as dumping grounds

In recent years, U.S. direct investment in developing countries has represented almost half of the total invested by OECD nations, both in terms of stock and flow. In 1981, for example, OECD countries invested $14.6 billion in developing nations, of which U.S. investors made up $6.4 billion.[44] The share in total U.S. foreign investments in the Middle East, however, has been relatively small: Egypt, Saudi Arabia, and Iran together received less than one-tenth of one percent of all direct foreign investments made in 1981. Nevertheless, U.S. investments in developing countries are important mechanisms for technology transfer, and OPIC is the primary government channel for directing and encouraging them.

Because OPIC is charged with encouraging investments that do not pose potential adverse economic impacts on U.S. employment and the balance of trade, its review process for prospective projects constitutes the most extensive preproject impact analysis carried out by any U.S. agency of purely commercial projects. OPIC has refused assistance to projects with potential adverse impacts, including some high-technology projects.[45] Congress has required OPIC to carry out developmental impact assessments, in light of what was perceived by some Members of Congress as a lack of sufficient detailed evidence to permit anticipation of economic and social effects. Criteria for assessing impacts include employment, technology transfer, productivity, multiplier effects on other industries, contribution to host government revenues, foreign exchange, concentration of project ownership, environmental and safety effects, and compatibility with other development assistance programs.[46] Thus, OPIC takes local impacts, including technology transfer, into account in its project review.

On the other hand, since 1981, Congress has directed OPIC to consider the potentially adverse effects of performance requirements, and to consider issues such as sensitivity of U.S. imports and the competitiveness of U.S. exports. OPIC reports indicate that 51 percent of all Near Eastern projects reviewed had performance requirements, the highest level of any geographical region of the world. Local content regulations, particularly in energy and minerals projects, have been most common. Of the Middle East projects reviewed, Saudi Arabia and Egypt have had the highest number of projects with performance requirements. However, in fiscal year 1982, none of these projects was found to reduce substantially positive trade benefits to the United

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[44] OECD, *Investing in Developing Countries*, p. 17.

[45] U.S. Overseas Private Investment Corp., *1981 Annual Report*, p. 49.

[46] See Senate Foreign Relations Committee, *Overseas Private Investment Corporation*, hearings, June 11, 12, 1980, pp. 84-90.

States.[47] OPIC is designed to complement but not duplicate the goals of U.S. development assistance, and project reviews are designed to carry out this function.

OPIC operates a small contractors' guaranty program, which supports exports of technical services and is designed to improve the positions of U.S. engineering and contracting firms operating in the Middle East. In addition, OPIC can provide insurance against the risk that a licensing or management fee will not be paid and can insure the capital investment of the license itself as part of the overall investment, assuming that it extends for a minimum of 3 years. Both of these programs directly promote technology transfers.

OPIC's insurance against expropriation of property is a support for firms that transfer technology and have long-term overseas involvement. OPIC's record of settlement has been good. By the end of 1982, the corporation had settled 134 claims. In 1983 alone, 17 claims were settled, with payments amounting to more than $6 million. It is important to note that $10 million has been paid in settlements of four de facto expropriation cases arising from investments in Iran. OPIC is pursuing in the Iran-U.S. Claims Tribunal its own claims against Iran that arose from these payments. OPIC's interpretation of what constitutes expropriatory action could presumably include host government requirements that the investor make proprietary technology available to those outside the original agreement.[48]

In contrast to export promotional programs, OPIC financing and insurance programs for overseas investment in developing countries contribute directly to technology transfers. The relatively small share of direct investment in Middle Eastern nations indicates that U.S. firms have found other regions, South America in particular, more attractive as sites for investment. Nevertheless, as Middle Eastern nations attempt to expand technology transfer through promotion of foreign investment, these programs could be used more extensively.[49]

INTERNATIONAL AGREEMENTS AND NEGOTIATIONS

International agreements relevant to technology transfer to the Middle East include the GATT and OECD subsidies codes agreements, discussed in chapter 2, and commercial treaties between the United States and individual Middle Eastern nations. In addition, United Nations negotiations regarding a proposed code governing technology transfers have increased awareness of LDC technology transfer issues.

Since the 1960's, developing nations have attempted to improve their ability to bargain for and acquire technology from the developed nations by working through a number of organizations, the most important of which is the United Nations Conference on Trade and Development (UNCTAD). In 1980 the U.N. General Assembly adopted the draft code on technology transfer as an advisory instrument only. The thrust of the proposed code is to promote technology transfer to developing nations through limitations on licensing practices, promotion of exchange of technological information, and indigenous technology development.[50]

Nevertheless, the code has not been formally adopted, signifying the ongoing discord between the developing and developed nations. At the heart of the dispute is the call from developing nations to loosen the protections of the Paris Convention, administered by the World Intellectual Property Organization, which governs international agreements on patents. U.S. patent laws provide greater protection to patent holders than the Convention does, and the United States has consistently opposed loosening the international agreements. In the opinion of U.S. spokesmen, loosening the restrictions would not aid developing nations but would simply reduce the incentives for U.S. firms and firms from other developed countries to invest in the Third World, thereby limiting technology transfer. In addition, not all new technology developments are covered by patents. Middle Eastern nations have participated in the debates over the proposed technology transfer code. Because their purchases of patents and licenses have been extremely limited, the significance of the debate for Middle Eastern countries is in the seminars and in workshops offered by UNIDO and regional U.N. agencies devoted to the study of technology transfer and science and technology policies.

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[47] U.S. Overseas Private Investment Corp., "OPIC Experience with Trade-Related Performance Requirements," fiscal years 1981 and 1982, papers.

[48] S. Linn Williams, "The Transfer of Technology to Developing Countries," *Federal News and Bar Journal*, May 1983, p. 269.

[49] Sam Ayoub, "How a U.S. Businessman Operates in the Middle East Today," *Tax Executive*, vol. 35, October 1982, p. 78.

[50] UNCTAD, *UNCTAD Bulletin*, No. 192, April 1983, pp. 13-14.

In addition to the international negotiations and agreements mentioned above, international treaties between the United States and Middle Eastern nations have set the immediate context and parameters for the involvement of U.S. firms. In 1982 the U.S. initialed a bilateral investment treaty granting Egypt "most-favored-nation" status. The treaty, which covers treatment of foreign investments, compensation for expropriation, transferability of payments, and the settlement of disputes, is not yet fully implemented. Such treaties give U.S. firms an extra level of protection, but effects on exports are difficult to assess. In contrast to many other supplier nations, the United States has bilateral trade accords only with Brazil among the developing nations.

Except with Egypt, there are no official and comprehensive U.S. trade or investment agreements with Middle Eastern nations, although the United States and Israel began negotiations in 1984 on a joint free trade agreement. The Department of Commerce announced it has no plans to grant Saudi Arabia most-favored-nation status, although that nation has requested it.[51] A bilateral investment treaty with Saudi Arabia is, however, a possibility. Egypt is thus the only Middle East nation with which the United States has officially promoted U.S. commercial involvement through trade or investment agreements.[52]

Technology transfer involves international trade in services, an export area of growing importance to the United States but one not effectively covered by international agreements. U.S. negotiators have attempted to introduce proposals for such an agreement, but none has yet been approved. A major difficulty in this regard is a lack of data needed to effectively analyze service trade. A number of congressional proposals have been made to improve the collection of such data, and to limit foreign access to the domestic U.S. service market to promote "reciprocity." For a variety of reasons discussed in chapter 2, improved analysis of service trade could contribute to the development of more effective U.S. policies affecting technology transfer.

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[51] "Saudis Rebuffed Over Most-Favored-Nation Status," *Middle East Economic Digest*, May 13, 1983, p. 11; "Investment Treaty Protects U.S. Firms," *Middle East Economic Digest*, Oct. 8, 1982, p. 19. Saudi Arabia contends that U.S. refusal to grant Generalized System of Preferences (GSP) status constitutes a violation of a 1933 treaty. U.S. law excludes OPEC countries from GSP status granted to most developing countries.

[52] U.S. Government actions prohibiting Kuwait from holding leases on public lands may provide disincentives for trade with that nation. See House of Representatives, Subcommittee of the Committee on Government Operations, *Federal Response to OPEC Country Investment in the United States*, part 2—"Investment in Sensitive Sectors of the U.S. Economy: Kuwait Petroleum Corporation Takeover of Sante Fe International Corporation, October 20, 22, November 24, and December 9, 1981," and part 3—"Saudi Arabian Influence in Whittaker Corporation," Apr. 6, 1982. It should be noted that the U.S. and Morocco have signed a bilateral investment treaty.

DEVELOPMENT ASSISTANCE

While technology transfer occurs primarily in the commercial marketplace, U.S. Government assistance programs, including bilateral economic and military assistance and multilateral programs, play a particularly important role in developing nations such as Egypt. Development assistance serves a number of objectives; humanitarian, political, commercial, and strategic interests all figure in at different times and in different ways. Since the early 1970's, the basic thrust of American economic assistance programs has been to help the poorest developing countries meet the basic human needs of their populations.[53] Agriculture, rural development, population planning, health, education, and nutrition have all been major priorities of the Agency for International Development (AID) programs. Thus, programs undertaken in the last decade differ somewhat from earlier programs targeting growth sectors and infrastructure building in developing nations.

Generally speaking, U.S. assistance programs in the Middle East have supported provision of products and food rather than aiming specifically to transfer technology in industrial and service systems examined by OTA. The major type of assistance provided by the United States to nations in the Middle East is carried out through the ESF. ESF programs are intended to provide immediate assistance and may be used for balance-of-payments support, financing of infrastructure and capital projects, and commodity imports. The major recipient of development assistance funding, as opposed to ESF funding, in the Middle East has been the Yemen Arab Republic, which was provided with $27 million during fiscal year 1983. A third type of assistance is the Public Law 480 program, which is used to finance U.S. food exports. Egypt is the major recipient of Public Law 480 funds, and in recent years loans and grants have totaled $300 million. However, Jordan, Syria, and the Yemen Arab Republic have also received smaller amounts of Public Law 480 funding, which contribute to development assistance and also open export markets for U.S. firms.[54]

Photo credit: Overseas Private Investment Corporation

More than 670,000 metric tons of U.S. grain are handled annually at the Marine Shipping Corporation's off-loading facility in Port Said, Egypt

Technology transfer is one among a variety of concerns that AID officials take into account in designing programs, so it would be a mistake to place too much emphasis on technology transfer as a criterion for program evaluation. U.S. assistance programs nevertheless affect the volume and nature of commercial technology transfer, and insofar as some of these programs are designed to promote technology transfer, their effectiveness is an important concern for U.S. policymakers.

DEVELOPMENT ASSISTANCE AND COMMERCIAL PROMOTION

An unresolved issue in debates about U.S. assistance policies is the relationship between assistance programs and the commercial activities of U.S. firms. A related issue concerns the role of U.S. assistance programs in developing the private sector in host countries.

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[53] Congress passed the New Directions Mandate in 1973, which directed AID to set these as priority areas.

[54] Congressional Budget Office, cited in GAO, *Donor Approaches to Development Assistance: Implications for the United States*, GAO/ID-83-32, May 4, 1983, p. 17.

About 40 percent of U.S. official development assistance has been classified as "tied" or partially tied aid, which restricts associated procurements.[55] On the other hand, the grant element of U.S. aid has risen in recent years to 82 percent of the total commitments in 1982. Thus, while ODA provided by the United States includes a comparatively high percentage of grants, the assistance is in many cases "tied" by procurement regulations which bring contracts to U.S. and host country firms.

Because critics of "mixed credits" say they commercialize aid and thereby distort its goals, the United States has traditionally opposed their use. Mixed credits combine foreign aid with export financing so that loans are provided at interest rates below the minimums set in the OECD export credit arrangement. France uses mixed credits extensively, while West Germany, Japan, and Britain use them only moderately. During the first 10 months of 1982, 78 mixed credits were awarded by OECD nations. They were valued at $1.6 billion, and 23 of them were extended by France. In contrast, the United States has generally used mixed credits only in unusual circumstances. The OECD members have agreed that when mixed credits (with grant elements of 20 to 25 percent) are used, other countries will be notified in order to make the action transparent and subject to international competition. To the extent that nations employ mixed credits to subsidize exports and large-scale development projects, they explicitly link commercial promotional polices to development assistance.

The charters of the Export-Import Bank and of AID do not prohibit the use of mixed credits, but neither organization has used them extensively. The 1983 Trade and Development Enhancement Act calls for institution of a mixed credit program by AID and the Export-Import Bank.[56] The purpose is to allow the U.S. Government to provide concessional financing matching that of other supplier nations. Other legislation was introduced in 1983 requiring the Export-Import Bank to cooperate with the Commodity Credit Corporation in subsidizing agricultural exports.[57] Proponents of these initiatives hope to expand the financing capability of the United States because in their view a billion dollars' worth of sales have been lost because the United States does not offer competititive financing. Opponents charge that it is unfair and inappropriate for the American taxpayer to subsidize exports. Their special concern is that mixed credits may distort the goals of development assistance by shifting aid more toward the middle-income countries and to commodity imports rather than technical assistance.

The Export-Import Bank and AID have established guidelines for the selective use of mixed credits, and two mixed credits were granted for projects in Cyprus and Indonesia in early 1984. The goal of the program is not to match every mixed credit provided by other supplier governments, but rather selective use of mixed credits in order to discourage their use elsewhere. Linked to efforts to persuade OECD members to disavow the use of mixed credits, U.S. officials see the strategic use of mixed credits as a means of increasing bargaining leverage needed to build a new consensus. The critical question for U.S. policymakers is whether selective use of mixed credits can serve this end, or whether the result will be to institutionalize them.

Proponents of mixed credits point to a few cases where the use of such financing has been critical to U.S. sales in Egypt, a major recipient of mixed credit financing. In 1979 a consortium of U.S. telecommunications firms lost to a European consortium a contract for an expansion of Egypt's telephone network owing, in the opinion of many observers, to the concessional financing offered by the Europeans[58] (see ch. 6). The loss of this major contract led the United States to develop a new approach to financing. In 1981 the Export-Import Bank made a $7.7 billion loan commitment to Egypt in conjunction with AID funds used on other parts of a large telcommunications project. Although the Export-Import Bank maintains that the two transactions were separate, many view the financing as a case of mixed credits.[59] Thus, in recent years, AID spent almost $242 million during the 1978-82 period on telecommunications in Egypt, and the associated contracts were awarded to U.S. firms. The terms of the financing are extremely soft: a $202 million grant and a $40 million loan have been provided. The loan will be repaid at 2 percent interest rates over the first 10 years, and then at 3 percent annually thereafter. The repayments will thus take place over 40 years and in 61 installments.[60] In the opinion of experts, the soft financing provided through AID has been the critical factor preserving a presence for U.S. telecommunications firms in the Egyptian market.

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[55] Organization for Economic Cooperation and Development, *Development Cooperation, 1983 Review* (Paris: OECD, 1983, pp. 196-197.

[56] Testimony prepared for Subcommittee on International Economic Policy and Trade, House Committee on Foreign Affairs, Oversight Hearing on the Tied Aid (Mixed Credit) Program, Jan. 26, 1984. Senate Commmittee on Banking, Housing, and Urban Affairs, *Export-Import Bank Amendments of 1983,* Mar 22 and 24, 1983, pp. 2, 8, 104.

[57] S. 510, introduced Feb. 17, 1983, by Senator James Exxon.

[58] The Europeans offered 5.5 percent interest rates, payable over a 15-year period, while the Americans offered 8.5 percent. See Robin Day Glenn, *Financing of United States Exports of Telecommunications Equipment* (Washington, D.C.: Georgetown University Law Center, 1982), p. 31.

In 1982 a Trade Financing Facility (TFF) was set up as a mechanism for assisting U.S. firms competing for contracts in Egypt. Those evaluated as low bidders in terms of international procurement but which may lose a sale because of the financing offered by other supplier governments are eligible for TFF assistance. The program, designed specifically for use in Egypt, involves grants of up to $10 million in value. The use of the TFF is rather cumbersome, since it requires the U.S. firm to provide clear evidence of a foreign government export subsidy. Funding for the TFF diminished from $67 million during 1982 to $25 million, and the TFF has not been utilized in recent months.[61] Nevertheless, the establishment of the TFF, like the proposed amendments for Export-Import Bank use of mixed credits, reflects growing interest in linking commercial promotional policies to assistance programs.

Some question whether capital-intensive projects which have been supported by mixed credits contribute substantially to development. Others argue that such projects are essential for the development of Egypt's infrastructure and involve considerable technology transfers. The AID-funded telecommunications program, for example, involves substantial technology transfer in the form of training of ARENTO (Arab Republic of Egypt National Telecommunications Organization) personnel. Technical training courses in 18 fields have been offered to hundreds of individuals.[62]

The question of linkage between assistance and trade policies arises also in regard to private sector involvement in AID programs. In 1979 AID began a private sector development program in Egypt, with funding of $400 million. The program reflects a broader emphasis within AID to promote private sector initiatives in development assistance; these programs are under the jurisdiction of the new Bureau of Private Enterprise. In contrast to the pattern of the past, when government institutions were typically viewed as the primary instrument for achieving development goals, these programs aim to encourage the participation of U.S. business. They include credit financing facilities and technical assistance for the Egyptian private sector, incentives to promote U.S. private sector investment, and advisory services and technical training to develop institutional capabilities.[63] Considerable criticism, both from within AID and from without, has been directed at these private sector initiatives programs. One report on the program concluded that "the difficulties stem primarily from a lack of Egyptian institutional support, project design weaknesses, and the requirement to buy U.S. origin and source goods. It is doubtful that some projects will achieve their objectives."[64] Problems in coordinating with Egyptian counterparts have apparently limited the effectiveness of these programs.

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[59] Gary Clyde Hufbauer, *U.S. International Economic Policy, 1981, Draft Report* (Washington, D.C.: Georgetown University Law Center, 1982), pp. 7-22.

[60] Moore, p. 26. Interview with AID officials, Cairo, Egypt, April 1983.

[61] The Trade Financing Facility made only one loan, of $6 million, in the first half of 1983, to finance Westinghouse and GE sales of powerplants.

[62] Information provided by AID; training contract for ARENTO.

[63] These programs were stimulated by the Humphrey amendment to the International Security and Assistance Act of 1977.

[64] General Accounting Office, *Lessons Learned from AID's Private Sector Development Efforts in Egypt*, GAO/ID-83-18, Feb. 28, 1983, p. 11.

The goal of promoting the development of the Egyptian private sector is shared by Egyptian officials. As discussed in chapter 9, despite almost a decade of "open door" policies, the public sector remains overwhelmingly important in the Egyptian economy. While the mere size of the public sector does not necessarily indicate inefficiency, the need to promote market-oriented policies has been generally recognized. It is not surprising, in this context, that AID programs aimed at promotion of the Egyptian private sector have faced problems. As U.S. AID officials have tried to encourage Egyptian economic reform, they have come under criticism from Egyptians. Egyptian officials, wary of the large AID presence in Cairo, dissatisfied with the high costs of feasibility studies and administrative overhead required by AID, and aware of the freedom Israel has in spending economic assistance funds, have called for increased flexibility in use of AID funds.

In a general sense, Egypt and a few other recipient nations have become increasingly dependent on U.S. economic assistance. This raises a fundamental dilemma for U.S. policymakers: the more they encourage Egyptian leaders to liberalize the Egyptian economy, the more U.S. programs become vulnerable to charges that they involve too much outside interference; however, without real economic reforms, it is doubtful that AID programs will achieve desired results. In other words, while U.S. aid to Egypt has cemented friendly relations, extensive U.S. involvement has led to some disagreement about how to achieve proposed economic reform.

RECIPIENTS AND TYPES OF DEVELOPMENT ASSISTANCE

In addition to general questions concerning the overall effectiveness of U.S. economic assistance programs, there are unresolved questions about which nations should receive aid and what types of assistance should be provided. For example, during recent years, U.S. assistance has been targeted to the poorest countries. During a period of budgetary constraints, some believe that funds should be directed to a few of the countries most in need, and that this focus may result in improved administration of assistance programs.[65]

Nevertheless, middle and higher income developing nations need U.S. technical assistance. The Trade Development Program (TDP) is one of the few official U.S. Government programs directed toward middle-income developing nations. TDP finances planning services of U.S. firms needed by developing countries in major capital-intensive projects. These services assist the country in design, engineering, and construction. According to TDP, foreign firms have aggressively offered, in addition to export financing, feasibility studies and other project planning services at concessional rates. It has been estimated that the Italians currently provide $25 million-30 million, the French $100 million and the Japanese $200 million for these studies.[66] TDP's program includes support for feasibility studies; a $16 million budget was requested in fiscal year 1984.

Although TDP is a comparatively small program, it combines the goals of promoting development assistance and trade promotion in a unique way. TDP's policy is to provide assistance only where U.S. technology is internationally competitive but unlikely to be purchased without TDP intervention. In fiscal year 1983 about 11 percent of the program obligations were made for projects in the Near and Middle East and about $1 million was spent for these projects. The vast majority of these projects were in industrial and agricultural sectors, many of them in Turkey and Tunisia.

The United States-Saudi Joint Commission, which is fully funded by the Saudis, has sponsored a number of projects involving technology transfer, including vocational training, assistance in science and technology policy development, establishment of a national center for financial and economic information, solar energy research, and customs administration training. However, the shortage of appropriately skilled Saudi participants has, in a number of instances, hampered the implementation of programs. A Joint Commission for Economic and Technical Cooperation was set up with Oman in 1980, and AID is playing a major role in programs which are designed to develop manpower skills. Programs of this kind promote technology transfer needed for development and at the same time offer export opportunities for U.S. business. There is, however, no comprehensive strategy for promoting U.S. technology transfer and assistance to all upper and middle income nations in the Middle East. AID does, however, attempt to establish parallel financing with Arab donor countries.[67]

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[65] General Accounting Office, *Donor Approaches*, op. cit., p. iii.

[66] U.S. Trade and Development Program, *FY 1985 Congressional Presentation*, p. 2. See also House Foreign Affairs Committee, *Role of Private Sector in Development Abroad*, hearings, Feb. 24 and 25, 1982, p. 38.

Since Title V, on Science, Technology, and American Diplomacy, was inserted into the Foreign Relations Authorization Act of 1978, Congress has maintained a strong interest in promoting U.S. assistance programs involving science and technology. The law requires that the President report annually to Congress on the status of science and technology programs and agreements of and personnel requirements for U.S. officials working on these programs. This legislation was designed to promote programs involving science and technology transfer as an element of U.S. foreign policy.

There has been no consistent strategy for U.S. assistance programs in science and technology in the Near East. Among the projects funded under the $100 million science and technology program in Egypt, the largest program allocation is devoted toward building Egyptian science and technology institutions capable of comprehensive planning. The major emphasis of these programs has been to assist Egyptian leaders in formulating a more coherent science and technology policy, and in institution-building at the national policymaking level.

Photo credit: Saudi Arabian-United States Joint Commission on Economic Cooperation

Joint Commission projects include the development of an automated on-line bilingual inventory management and order processing system at the National Computer Center in Saudi Arabia

Only a few programs are aimed at providing direct assistance to the end-users of industrial technology; they include a management development project and a project designed to promote applied technology in smaller Egyptian enterprises. While such programs have been comparatively few in number, they undoubtedly are probably most likely to contribute to technology transfer in the sectors examined by OTA and perhaps to become self-sustaining.

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[67] General Accounting Office, *Status of U.S.-Saudi Arabian Joint Commission on Economic Cooperation*, GAO/ID-83-32, May 26, 1983, p. iv. See also AID, *Near East Bureau Strategy 1983-1988*, December 1983, pp. 29 and 75.

Egyptian officials and AID staff agree that these science and technology programs are important, and that they must set clearer priorities. The Near East Bureau of AID, accordingly, began an assessment of its science and technology programs in the fall of 1983 to this end. Considering the U.S. commitment to the science and technology program in Egypt, it is important that a clearer focus for these programs be developed, perhaps by projects that provide tangible benefits to Egyptian end-users of technology in industrial and service sectors.

Of all the technology sectors examined by OTA, medical services is undoubtedly the area where AID programs have been most important.[68] Traditionally, improved health care has been a major goal of U.S. assistance policies, and health care programs have been comparatively effective, as discussed in chapter 8. In 1982, $50 million in ESF funding went to support Egyptian health-care programs involving family planning, rural health, and education.[69] The thrust of AID programs has been to provide preventive health care to as many people as possible, especially those in rural areas.

In a sense, almost every program funded by AID involves some technology transfer, and this makes it difficult to assess the value and amount of AID resources devoted specifically to technology transfer. Only a small number of AID programs have industrial technology development as an explicit goal. AID programs are designed to achieve many goals; improving the success of technology transfers in complex industrial and service systems is just one. If U.S. policymakers decide to make this a top priority, it will be necessary to design programs that directly involve the users in recipient nations, to emphasize projects that have a strong economic rationale and are likely to be self-sustaining over the long term, and to encourage the involvement of U.S. firms having the required technology and those that are capable of operating effectively in the Middle East. U.S. economic assistance to Egypt in particular among the Islamic countries is so great that efforts to improve the effectiveness of the technology transfer component of programs there appear appropriate.

MIDDLE EASTERN STUDENTS IN THE UNITED STATES

One mechanism for technology transfer is the technical education of foreign students in the United States. Middle Eastern students trained in fields such as engineering, construction trades, mechanics and equipment repair, precision production, and health sciences may develop specialized skills needed in the technology transfer process in sectors examined by OTA. The number of foreign students in the United States has grown in recent years, and their education has become a policy issue.

The number and share of Middle Eastern students in the United States has grown rapidly during the last decade, but available evidence indicates that only a small proportion are enrolled in technical fields. In the 1981-82 academic year the number of foreign students studying in the United States rose to at least 327,000—growth both in absolute numbers and as a percentage of degree recipients. Moreover, in recent years an increasing number of foreign students have been receiving degrees in technical fields, such as engineering. The share of engineering doctorates awarded to non-U.S. citizens increased by a factor of seven during the last 20 years. In 1981, over half the graduating engineering doctorates were non-U.S. citizens.[70] In that year, 1,241 Ph. D.'s in engineering were awarded to non-U.S. citizens, of which 41 were awarded to Egyptians, 74 Iranians, and 4 Iraqis. In all fields of science and engineering, however, students from the Islamic nations of the Middle East have made up a relatively small percentage of doctoral graduates—less than 10 percent in recent years.

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[68] Health programs are generally not included in science and technology programs, except those that emphasize research.

[69] Total funding for all health-related AID programs was $100 million in 1982, according to AID officials in Cairo.

[70] National Science Foundation, *Science and Engineering Doctorates: 1960-81*, Special Report, NSF 83-309, pp. 8, 71.

There is currently no source of official U.S. Government data on numbers of foreign students enrolled by field of study in the United States, but overall Middle Eastern enrollments in various levels of graduate study (as opposed to numbers of doctoral recipients) are high.[71] In 1981, for example, while only 74 Iranians received doctorates in engineering, almost 56,000 Iranian students were in the United States, according to Immigration and Naturalization Service data.[72] According to data collected from 2,800 schools by the Institute for International Education, 74,390 Middle Eastern students were enrolled in U.S. educational insitutions in 1981-82, with the largest numbers from Iran, Saudi Arabia, and Lebanon. This represented almost 25 percent of all foreign students during that year.[73] Iran, before the revolution, and Saudi Arabia, currently, have been among the six largest countries of origin for nonimmigrant students in recent years. Since overall enrollments of Middle Eastern students have grown, Middle Eastern enrollments in technical fields of study may increase in the future. It is difficult, however, to evaluate the precise contribution to technology transfer in the Middle East. While some students prefer to remain in the United States, many return to their homelands to assume key positions in governments and firms importing technology.

America-Mideast Educational and Training Services, a nonprofit organization, provides information and assistance to Middle Eastern students interested in U.S. educational programs. Many of its programs are funded by the United States. For example, with an AID grant, the organization is bringing 600 Egyptian graduates and professionals to the United States to study. Currently, more than 1,600 Middle Eastern students are involved in these programs, a few involving education and training in-country.[74] Such programs, particularly those oriented toward training Middle Easterners in technical fields, can contribute to the technology transfer to the region. However, the technical training programs involve only a comparatively small number of Middle Eastern students.

The policy of the United States since the passage of the Immigration and Nationality Act of 1952 has been to admit nonimmigrants to study in the United States under certain conditions specified by law. The presumption has been that this policy served U.S. foreign policy objectives in a number of ways, for example, by cementing ties with developing nations and helping transfer technology. U.S. educational institutions have benefited economically, since four out of every five foreign students had their primary source of funds in personal income or family or home government support.[75]

Proposals have been made to restrict the number of foreign students in the United States, primarily for national security reasons. Two cases have involved added restrictions on study by Middle Easterners. An unprecedented investigation, spurred by the charge that many Iranians illegally resided in the United States, was carried out in the wake of the Iranian hostage crisis. The investigation revealed that 88 percent of the Iranian students had verified status to study in the United States. By early 1981 about 2,600 Iranian students were found to be illegally in the United States and were deported.[76] In the spring of 1983 the U.S. Government announced that Libyan students were barred from studying aviation or nuclear physics in the United States because such studies were detrimental to U.S. security. As discussed in chapter 9, however, Government sources did not have sufficient information to say how many Libyan students were studying in the United States; estimates ranged from 2,000 to 4,000 (in all fields and at all levels). In the summer of 1983, nine students were held for deportation hearings under the ruling.[77] Thus, in neither case were large percentages of students found to be illegally residing or studying in relevant fields.

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[71] The Immigration and Naturalization Service is now establishing a system to collect data on numbers of foreign students in the United States, by field of study, school and country of origin.

[72] Bayard L. Catron, "The President's Management Improvement Council Report on Foreign Students in the United States," July 1981, app. table 4.

[73] Institute for International Education, *Open Doors: 1981-82, Report on International Educational Exchange,* 1983. According to these data, there were 35,000 students from Iran, 10,220 from Saudi Arabia, 6,800 from Lebanon, and 6,180 from Jordan.

[74] AMID-East, September 1983.

[75] Craufurd D. Goodwin and Michael Nacht, "Foreign Students Still Flock to the U.S.," *Wall Street Journal,* July 21, 1983.

[76] Catron, ibid.

Lack of enthusiasm for restrictions on foreign students stems from the fact that U.S. schools and businesses benefit by educating and employing foreigners—sometimes in fields not popular among U.S. citizens. The open and excellent system of advanced education, moreover, continues to draw students from all over the world. Only in rare instances have restrictions on study by Middle Easterners been imposed. When they have been, the direct impact has been narrow.

Education and training of students from both U.S. educational institutions and corporate programs remains an important mechanism for improving the absorptive capacity of developing countries. The effects of these educational experiences are long-lasting, since familiarity with U.S. institutions increases the likelihood that interactions will continue after the foreign student returns to his or her native country. There are, on the other hand, often extra costs of educating foreigners that are incurred because of language difficulties and other cultural differences.

MULTILATERAL ASSISTANCE

During the 1970's the contributions of donor nations to multilateral organizations such as the World Bank and the United Nations grew as a share of official development assistance. In 1980 more than one-third of U.S. development assistance went to multilateral organizations, a slightly higher than average contribution.[78] Yet, the rate of increase has slowed, and major donor nations have all registered a decline in recent years in their multilateral contributions as a percentage of donor nations' GNP. The United Nations Development Program, which has been the central funding source for technical cooperation provided by U.N. agencies, has been receiving a declining share of multilateral funding. Meanwhile, technical cooperation programs of more specialized U.N. agencies have grown.

Viewed from the Middle Eastern perspective, those nations receiving economic assistance, such as Egypt and Algeria, depend much more heavily on bilateral than multilateral flows. Egypt, for example, received in assistance commitments more than eight times as much bilateral as multilateral assistance in 1981. By far the largest part of multilateral assistance was provided by World Bank-related agencies, such as the International Bank for Reconstruction and Development, the International Development Association, and the International Finance Corporation.[79] Like the other major oil-producing nations such as Saudi Arabia and Kuwait, Algeria has itself been a donor of multilateral assistance, valued at $10 million in 1981.[80] For most of the Arab world, and for Egypt prior to Camp David, multilateral aid from multilateral Arab sources such as the Arab Fund for Economic and Social Development and the Islamic Development Bank has been important.

American multilateral assistance through the United Nations has also benefited Middle Eastern nations through programs sponsored by specialized agencies such as United National Industrial Development Organization (UNIDO), International Labor Organization (ILO), the World Health Organization (WHO) and the International Telecommunications Union (ITU). UNIDO, for example, maintains a technological information exchange system and sponsors a number of projects and seminars in the Middle East. In sectors such as telecommunications, ILO training programs and ITU agreements importantly affect the development of indigenous technicians, standards, and international use and trade in equipment and services. Similarly, the regional U.N. organization operating in the Middle East has organized a number of conferences on technology transfer to the Arab world.

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[77] "Libyan Students Held as Risks Freed on Bail; Deportation is Expected," *New York Times*, Aug. 14, 1983.

[78] OECD, *Development Cooperation* (Paris: 1983), p. 211.

[79] Organization for Economic Cooperation and Development, *Geographic Distribution of Financial Flows to Developing Countries* (Paris: OECD, 1982), pp. 78-9. During 1981, these World Bank-related organizations provided almost two-thirds of the multilateral assistance received by Egypt.

[80] Organization for Economic Cooperation and Development, *Development Coooperation*, p. 158.

There are, however, few jointly administered economic assistance efforts in the Middle East involving the United States and other Western nations as a group, although in some cases donors provide complementary assistance. For example, the United States has participated in a World Bank-designed reconstruction package for Lebanon; the relief was primarily provided by Western countries. OECD has a Development Center, a Committee for Science and Technology Policy, and an ad hoc group on technology transfer to developing countries. OECD programs sponsor studies of technology transfer and development issues, but there are no joint programs involving members in development programs in the Middle East. This lack of coordination among donor nations has been identified by some observers as a growing problem. (The Development Assistance Committee of the OECD is primarily a consultative body, and the United States does not participate in efforts to coordinate assistance with other Western governments, except in the case of Africa.)[81]

Particularly in the area of technical assistance, critics say, the need for coordination of programs is great. The European nations have attempted, albeit with only moderate success, to establish joint economic and technical assistance policies toward the Middle East. Although AID has recently begun efforts to coordinate parallel funding with Arab donors, the United States has not cooperated with regional Middle Eastern organizations such as the Islamic Development Bank or the Gulf Cooperation Council in technical assistance. Political differences undoubtedly explain the lack of multilateral technical assistance efforts in the Middle East involving the United States.

In addition, only a small number of AID programs in the Near East are devoted to programs simultaneously involving more than one recipient country. The one exception to this pattern of bilateral assistance is the trilateral science and technology cooperation program involving Egypt, Israel, and the United States, initiated since the Camp David accords. This cooperation has been viewed as a "significant and concrete way to build the structure of peace" in the Middle East, and an important part of U.S. foreign policy.[82] From the beginning, it was recognized that the program, which involves scientists from all three nations working together, would be a difficult undertaking. Given the imbalance in science and technology resources between Egypt and Israel, the comparatively low priority that Egyptians have attached to cooperation with Israel in view of their longer relationship with the United States, and the need for open exchange of information, cooperation has proceeded slowly and has been limited to a few narrowly focused efforts. In 1981, for example, the U.S. National Institute of Allergy and Infectious Disease, Ain Shams University in Egypt, and Hebrew Univerity in Israel began a long-range project aimed at controlling three arthropod-borne diseases in Egypt and Israel. Other projects in agriculture and industry were also proposed, but few have been implemented. Nevertheless, the trilateral science and technology cooperation project remains an important, though still largely symbolic, multilateral effort which suggests the potential role for science and technology in American foreign policy toward the region.

Outside the health care sector, only a small number of programs have as their primary goal encouragement of industrial or service sector technology transfers in the sectors OTA examines in this report. While promotion of technology transfers needed to ensure better operation of industries and services appears to be a high priority for Middle East policymakers, the difficulties in designing assistance policies directed at improving technology transfer should not be underestimated. Projects aimed to promote technology transfer are people-intensive and require considerable lead time and follow-on activities. In addition, technology transfer projects generally require more coordination between the assistance-providing agencies of the U.S. Government and the local agencies and firms.

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[81] Overseas Development Council, *U.S. Foreign Policy and the Third World, Agenda 1982*, p. 119.

[82] House Committee on Foreign Affairs, Letter of Transmittal, *Planning for Trilateral Scientific and Technological Cooperation by Egypt, Israel, and the United States*, Oct. 31, 1980, p. 1.

MILITARY AND STRATEGIC POLICIES: CONTROLS ON TECHNOLOGY TRADE AND TRANSFER

During the past decade, American controls over exports—particularly over exports of advanced technologies and equipment—have expanded. The Government has increasingly used these controls to regulate U.S. exports worldwide, including technology trade with nations in the Middle East. The impetus for controls stems from a number of sources, some of which are not specific to the Middle East. Concerns about nuclear proliferation and about potential diversions of exports from third countries to the Soviet Union are among those general factors. In addition, factors more specific to the Middle East, such as the adversarial nature of U.S. relations with countries such as Libya and strong U.S. support for Israel, the apparent nuclear ambitions of some Middle Eastern nations, the alliance of some Middle Eastern countries to the Soviet Union, and the comparatively high level of conflict and terrorism in the region have all stimulated attempts to restrict U.S. exports of advanced civilian technologies to the Islamic Middle East.

As noted earlier in the discussion of the foreign policy context, controversy over controls has focused specifically on exports of military equipment, such as the AWACS early warning plane. However, as detailed below, a number of other American policies, such as foreign policy controls, antiboycott policy and restrictions on American overseas business practices, more directly affect civilian technology trade. These various controls on exports, instituted for military and political purposes, distinguish American policies affecting civilian technology transfer from those of other supplier nations.

Before examining regulations limiting technology trade, it is important to understand arguments for and against controls. OTA has analyzed these general debates in the context of East-West technology trade.[83] Proponents argue that restrictions on American exports can be effectively used as a lever in achieving American foreign policy goals. Given the inappropriateness of the use of military force in many situations and the unavailability of other policy instruments, proponents view trade restrictions as a way to demonstrate American condemnation of certain actions taken by foreign governments.

There is widespread agreement that restrictions are necessary for exports of military equipment critical to the national security of the United States. However, there is less agreement concerning restrictions such as foreign policy controls. The President is empowered by the Export Administration Act[84] to use such controls in order to achieve political goals (e.g., applying sanctions against nations determined to be supporting terrrorist activities). In August 1984, discussion was under way in Congress on possible revision of that legislation. Foreign policy controls have been used to reduce the flow of nonmilitary exports to specific nations in the Middle East. Other types of regulations affecting American business actitivies—such as the Foreign Corrupt Practices Act and antiboycott policies—are viewed by proponents as necessary for upholding higher principles such as fairness of business practices and nonsupport for the Arab boycott of Israel. According to proponents, the costs of the controls in lost sales are relatively minor in comparison to the political benefits to the United States when the United States takes a strong, political and principled stand.

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[83] See *Technology and East-West Trade* (Washington, D.C.: U.S. Congress, Office of Technology Assessment, OTA-ISC-101. November 1979), and *Technology and East-West Trade: An Update* (Washington, D.C.: U.S. Congress, Office of Technology Assessment, OTA-ISC-209, May 1983).

[84] The Export Adminstration Act expired on Sept. 30, 1983. Congress was debating proposals for renewal and revision of the act in late 1983 and early 1984.

Few question the need for controls on exports of military and sensitive nuclear equipment and technology, but a number of arguments have been made against expansion of other types of controls. Opponents point to what they view as the inordinant costs of controls to U.S. firms and, in some cases, to the United States more generally. Market losses, growth in foreign sources of components, and the perception abroad that the United States is an unreliable supplier are, in the view of the opponents, among the considerable costs. Since many suppliers abroad can supply equivalent technology and equipment and few foreign supplier governments have instituted such controls, opponents of controls see them as simply injuring U.S. business without effectively restricting the ability of the recipient to actually acquire the technology. Opponents see controls as heightening unnecessarily the political dimension of U.S. economic interactions with the Middle East.

Debates continue about the appropriateness and effectiveness of controls on advanced civilian technology and products, both at the general level of controversy over renewal of the Export Administration Act, as well as over specific cases such as the institution of foreign policy controls on exports to particular Middle Eastern nations. These debates over controls are confounded by the fact that it is often difficult to measure their precise trade effects. In general, it has been easier to institute than to withdraw controls. The discussion that follows briefly reviews U.S. export controls and evaluates their significance for technology trade and transfer to the Middle East.

NATIONAL SECURITY AND FOREIGN POLICY CONTROLS

The Export Administration Act of 1979 is the central piece of legislation that established the authority of the President to control exports for national security and foreign policy reasons. The purpose of national security controls is to restrict exports that contribute significantly to the military potential of another country and would be detrimental to U.S. national security. The controls are exercised on applications for export of items contained on the Commodity Control List, which includes both items that are unilaterally controlled by the United States and those controlled by CoCom (the allied Coordinating Committee for Multilateral Export Controls) to restrict trade with the Soviet bloc nations. In most cases, the Office of Export Administration in the Department of Commerce reviews applications for export and makes a determination, but the Departments of Defense, State, and Energy, among others, sometimes review applications or exercise licensing authority, depending on the type of commodity.[86] In addition, the U.S. Government controls all exports of munitions and military equipment.

In reviewing export license applications, the Department of Commerce makes determinations based on, among other factors, relations between the United States and nations to which exports are destined. All of the nations of the Middle East, with the exception of Libya, are categorized in Country Group V, which includes most of the nations of the world, such as Great Britain, Japan, West Germany, and France.

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[86] See U.S. Department of Commerce, International Trade Administration, Office of Export Admnistration, *Export Administration Annual Report FY 1982* (Washington, D.C.: U.S. Government Printing Office, 1983), pp. 14-15 for a list of agencies involved in review of export licenses. The role of the Department of Defense in particular has been expanded in recent years. See Paul Mann, "New Center to Oversee Export Licenses," *Aviation Week and Space Technology,* Sept. 19, 1983, p. 71.

National security controls restrict the export of military and strategically sensitive items (including dual-use items) which have potential military application in the exporting country or which might be diverted to the Soviet Union. In recent years, only a small number of denials have been made for national security reasons on exports to the Middle East.[86] By far, the majority of applications for export to the Middle East are processed through the "front door" licensing procedure of the Department of Commerce, where a preliminary screening finds them not in violation of the export regulations.

With respect to civilian technology trade with the Middle East, foreign policy controls are more important than national security controls in restricting specific types of U.S. exports, particularly aircraft. Foreign policy controls are instituted by the President in order to achieve political purposes, such as imposing sanctions against nations violating human rights or supporting terrorism, or in order to promote regional stability by prohibiting the export of certain military items.

The most extensive use of foreign policy controls in recent years has been those applied to trade with Libya. Foreign policy controls were imposed on exports of certain aircraft, helicopters, and aircraft parts and avionics to Libya in October 1981. In 1982, as Libyan military activity in neighboring nations increased, the controls were made progressively stricter. On March 10, 1982, the controls were tightened to include an embargo against Libyan oil, following a closure of the Libyan embassy in Washington and a request from President Reagan that all Americans residing in that nation depart. As a general policy, licenses for all high-technology exports to Libya are denied and all exports, except for food, medicine and medical supplies, and nonstrategic products require licenses. Libya has thus been placed in a special country category that requires most exports to be licensed. The controls on exports to Libya are extensive, but during the latter part of 1982, 1,650 licenses for export of nonrestricted goods valued at $340 million were approved, while 16 valued at $13.8 million were denied.[87] Trade with Libya continues, but is limited to specific types of exports and at a much reduced level.

Foreign policy controls denying items to countries involved in terrorist activities have been applied to Iraq, the People's Democratic Republic of Yemen, Iran, and Syria (in addition to Libya) in recent years. These controls apply to exports of aircraft valued at $3 million or more and to helicopters over 10,000 pounds.[88] In addition, other commodities and technical data under national security controls are covered if the export is valued at $7 million or more and destined for a military end-user or end-use. In March 1982, Iraq was deleted from the list of nations subject to antiterrorism controls.

The regional stability controls require a validated license for export of military vehicles and certain commodities used to manufacture military equipment, and they have been applied in recent years specifically to Libya, Iran, and Iraq. However, these controls are effective vis-à-vis virtually all nations except NATO countries. In fiscal year 1982, denials for exports of military vehicles to Iran (for a total of $38 million) and to Iraq (for a total of $204 million) were made. Formerly, during the hostage crisis, the United States instituted an embargo of exports of all types, except for food and medicine, to Iran.[89] Foreign policy controls were reinstituted against Iran in early 1984.

Under section 6 of the Export Administration Act, the Secretary of State is required to provide an explanation when controls are instituted. The explanation must include consideration of a variety of criteria, such as the probability that the controls will achieve their intended results, their compatibility with other foreign policy objectives, the anticipated reactions of other countries, effects on the competitive position of the United States, and feasibility of enforcement. The Secretary is not, however, strictly bound by these criteria. (Section 3[8] of the act stipulates that the President shall make efforts to secure the reduction of terrorism through international agreement or cooperation before resorting to the use of foreign policy controls.) Given these various statements in the act, there is considerable ambiguity concerning the conditions required to institute or remove antiterrorist controls. Generally speaking, the Department of State is reluctant to institute these controls unless there is evidence of repeated and serious problems. Past experience has shown that controversy inevitably develops concerning changes in controls, which are often easier to institute than to withdraw.

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[86] Information provided by the Office of Export Administration, Department of Commerce, March 1983.

[87] Department of Commerce, *Export Administration, 1982,* p. 32.

[88] After March 1982, sales of civilian aircraft for use by regularly scheduled airlines based in Syria and PDR Yemen were exempted from the controls.

[89] This action was taken on Apr. 7, 1980, and followed suspension of oil imports from Iran, denial of exports of military equipment and spare parts, and freezing of Iranian assets in the United States. Diplomatic relations with Iran were severed in April 1980.

Nor is there any clear agreement concerning the effectiveness of the controls. Impacts measured in reduced sales are most apparent in the case of exports to Libya. Prior to 1981, when foreign policy controls against Libya were first introduced, U.S. exports amounted to $813 million, and the United States was a major importer of Libyan oil. Subsequently, the U.S. share of total Libyan imports declined from 5.4 to 2.1 percent and exports fell at an annual rate of $500 million. Although some of this decline is attributable to Libyan economic difficulties, experts conclude that foreign policy controls were the most important factor. However, there is little evidence that Libya has moderated its policies because of the imposition of these controls.

The impact of foreign policy controls is most evident in civil aircraft sales. As discussed in chapter 7, new orders of large U.S.-origin transport aircraft destined for the Middle East dropped from a peak of $1.1 billion in 1979 to $89 million in September 1982. In contrast, Airbus orders for the same countries were valued at $289 million in 1979, and $661 million as of September 1982. Undoubtedly, various factors explain this shift in market share, including differences in export finance and the desire in the Middle East to diversify sources of supply. U.S. controls were unusually restrictive in this area and contributed to the decline in the U.S. market position.

It is difficult to assess precise impacts of the controls. Aircraft industry sources claim that $500 million in direct sales were lost by the end of 1981, as were 20,000 jobs in the aircraft and related supply industries. Department of Commerce sources estimate that $10 billion worth of future aircraft contracts may have been jeopardized during the next decade.[90] Recent modifications of the controls to permit sales to regularly scheduled commercial airlines were taken in order to mitigate such commercial impacts of these controls.

As is the case with foreign policy controls applied to nations in other parts of the world, only in rare instances has use of controls clearly caused a change in the policies of the target country. A major problem arises from the ability of other foreign suppliers to provide comparable technology and products, allowing buyers to simply go elsewhere. Nevertheless, proponents would argue, the controls demonstrate the firm resolve of the United States to condemn acts of international terrorism. Whether or not the costs outweigh the benefits clearly depends on whether one believes that taking such a "principled" stand is appropriate or effective.

NUCLEAR NONPROLIFERATION CONTROLS

Nuclear nonproliferation controls have been authorized by the Nuclear Non-Proliferation Act of 1978 and the Export Administration Act. These controls restrict the export of weapons-usable materials (plutonium and highly enriched uranium), sensitive nuclear facilties, and classified and sensitive nuclear technologies. Dual-use commodities which can be used indirectly (whether or not the item is specifically modified for purposes such as designing, constructing, fabricating, and operating nuclear explosive devices or facilities) are also included on the Nuclear Referral List, which is incorporated in the Commodity Control List. In reviewing applications for export, the nonproliferation credentials of the recipient nation, the guarantees applicable in the specific case, the significance of the export for nuclear purposes and its availability elsewhere, and its stated end-use are taken into consideration.

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[90] Department of Commerce, *Export Adminstration Annual Report, 1982,* op. cit., p. 144.

These controls are consistent with the Treaty for the Nonproliferation of Nuclear Weapons (NPT) which requires International Atomic Energy Agency (IAEA) safeguards on all such equipment, materials, technologies, and facilities. This requirement for safeguards on exported fissionable material has been clarified and expanded by the Zangger committee guidelines. This is an informal agreement among the 21 NPT supplier state signatories that they will not export any item on the Zangger committee's trigger list unless it is subject to IAEA safeguards, a no-explosive-use pledge is obtained, and the assurance is received that the recipient nation will not retransfer this item. The United States also subscribes to the export guidelines of the Nuclear Suppliers Group.

As outlined in chapter 9, only in a few instances have U.S. nuclear exports been made to nations in the Middle East, which undoubtedly reflects the strength of these controls. Between July 1, 1981, and June 30, 1982, U.S. exports of dual-use and nuclear-related equipment to Middle Eastern countries were valued at approximately $330 million, according to the General Accounting Office.

In a few instances, such as the export of lasers and related equipment to Iran in 1978, controversy grew regarding whether or not authorization of exports had been appropriate.[91] Such examples of controversy have not been common. Nevertheless, since the Department of Commerce deals on a case-by-case basis with applications for export of items on the Nuclear Referral List, some critics favor extending the controls to include a blanket denial for export of dual-use items, such as large-scale computers, to nations not signatories to the NPT. In recent years only about 6 percent of all dual-use exports (most of them computers) have gone to the nations of the Islamic Middle East.

Because U.S. controls on exports of nuclear equipment and technology are comparatively strict, the major challenge to the nonproliferation regime has been the policies of other supplier governments. As chapter 9 outlines, in a number of significant cases, the United States has succeeded in dissuading other nations from providing sensitive materials or technologies, or in requiring safeguards and other assurances. Major steps were taken under the Carter administration to extend these controls and to make nonproliferation a high-priority issue in U.S. foreign policy. Congressional interest began earlier under the Nixon and Ford adminstrations, when a number of bills were introduced. In the future, sensitive nuclear contracts, the scope of safeguards, and other nonproliferation regulations may become factors in the competition for exports of nuclear technology, in which a growing number of "smaller" supplier nations will participate. OTA's findings in chapter 9 point to the need to develop policies that bring the new suppliers into the nonproliferation regime by persuading them to require return of spent fuel, by requiring recipients to agree to safeguards, and by limiting exports of sensitive reprocessing and enrichment facilities.

Bilateral cooperation agreements in nuclear energy have been central to U.S. nuclear export policy. The existence of such an agreement is a prerequisite for export of U.S. nuclear technology, equipment, and fuel. Bilateral agreements have been used to implement and extend restraints agreed on multilaterally and to bring nonnuclear states into the international nonproliferation regime. As discussed in chapter 9, the bilateral nuclear agreement with Egypt was accompanied by that nation's accession to the NPT.

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[91] For information on the value of U.S. dual-use and nuclear exports, see General Accounting Office, *Controlling Exports of Dual-Use, Nuclear-Related Equipment*, GAO/NSIAD-83-28, Sept. 29, 1983. See General Accounting Office, *Circumstances Surrounding the Government's Approval of Nuclear-Related Exports to Iran*, report to Senator Cranston, Mar. 17, 1980.

The United States has also worked through the IAEA, the primary institutional mechanism for carrying out inspections to ensure that countries are living up to their commitments to enforce safeguards against proliferation. The IAEA does not have police power, nor does it have roaming rights to inspect any and all facilities without prior notice. Doubts about the reliability of IAEA safeguards grew in light of Iraq's nuclear program, since that nation was a signatory to the NPT but attempted to acquire sensitive facilities that could be important for a weapons program. Israel's preemptive strike against Iraq's Tammuz 1 research reactor heightened concern that nations would take unilateral actions weakening the influence of international nonproliferation norms. Concerns have also risen about the politicization of the IAEA. In 1982 the United States withdrew from participation in the 26th General Conference of the IAEA after member states denied credentials to Israel's delegation, but later resumed full participation in the IAEA. The dangers of politicization are great, since the agency remains the primary mechanism for verification of safeguards enforcement. While the IAEA cannot prevent long-term efforts to develop weapons capability, it does contribute to the international nonproliferation regime. In order to influence its programs and maintain support for international safeguards, the United States must participate in the IAEA.

There have been few changes in U.S. nonproliferation policies directly affecting nations in the Middle East. Reagan administration policies ending no-reprocessing export restraints and stressing the need to ensure that the United States is viewed as a reliable supplier have had the most significant effects on nuclear programs in nations such as Japan.[92] Under the Reagan administration, prevention of nuclear weapons proliferation has been seen more as a political than a technical problem. In the Middle East, for example, promotion of regional stability and recognition of the legitimate security needs of nations in the region have been viewed by administration officials as important to nonproliferation goals.[93]

Critics worry that recent decisions affecting new supplier countries represent a relaxed attitude toward nuclear exports which could have repercussions in the Middle East. The decision to supply spare parts for India's Tarapur reactor in 1983 raised concerns because India has refused full-scope safeguards and because India may become a supplier of nuclear technology to the Middle East.[94] Following a decision in late 1982 permitting France to sell uranium to India, critics worried that the commitment to require full-scope safeguards would be further eroded. Critics of these decisions worry that countries such as India and Pakistan may be more willing to export sensitive nuclear equipment and technology in the future to the Middle East. Proponents, reiterating their commitment to nonproliferation goals, argue that it is necessary to deal with non-NPT states through provision of nonsensitive nuclear technologies in specific cases in order to influence their programs.

Over the years, Congress has enacted a number of provisions that reinforce and extend prohibitions on the provision of economic and military assistance to nations that do not accept full-scope safeguards, but do acquire sensitive facilities. The Symington and Glenn amendments, passed in 1976 and 1977, respectively, are the central examples of this legislation. In addition, since 1978, Congress has placed limits on the ability of the Export-Import Bank to provide funding for nuclear exports. All Export-Import Bank actions in this area require congressional review, and in recent years Export-Import Bank support for such exports dropped sharply. The restrictions on nuclear exports have undoubtedly served to reduce

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[92] Proponents of stiffer regulations on exports of reprocessing facilities argue that the loosening of exports to nations considered not to be proliferation risks opens the door to the possibility that some day exports could be extended to other nations, as well.

[93] See Warren H. Donnelly and Joeseph F. Pilat, *Nuclear Export Strategies to Restrain the Further Spread of Nuclear Weapons in the 1980's*, CRS Report No. 83-118 S, June 1983, pp. 53-56.

[94] In 1980, the Carter administration waived provisions of the act to sell India 38 tons of nuclear fuel. Philip Taubman, "Shultz Tells India that U.S. Will Drop Reactor-Parts Ban," *New York Times*, July 1, 1983, p. A4.

U.S. nuclear sales worldwide. In bidding for nuclear power stations in Egypt, however, U.S. firms unable to obtain U.S. Export-Import Bank financing joined Japanese firms in order to obtain financing.[95] This example, like reports of foreign sourcing of aircraft engines and other aircraft parts in the wake of U.S. foreign policy controls, illustrates that controls may stimulate firms to seek alternative options for financing and supply of parts.

It is impossible to measure the impact of U.S. nonproliferation controls on exports. Undoubtedly, the level of trade in nuclear technology and equipment with the the Middle East, both by U.S. and foreign suppliers, would be higher without such policies. The strict provisions incorporated in the U.S.-Egyptian bilateral agreement stand as model in that they provide a framework for the United States to assist Egypt in its commercial program while at the same time reducing the prospects for nuclear weapons proliferation. In addition, the United States has been successful in persuading other supplier nations to harmonize and broaden the scope of guidelines.

While nonproliferation controls have thus contributed to slowing the spread of nuclear weapons, during the years ahead the growth of Middle Eastern technical capabilities and the entry of new supplier states into the market will present significant challenges to U.S. nonproliferation policies. Chapter 9 outlines a number of policy options that could be used to further nonproliferation policy goals in the Middle East.

OTHER POLICIES INHIBITING TECHNOLOGY TRADE

Policies regulating the activities of U.S. businesses operating in the Middle East have long been viewed by businessmen as constraints on trade. The antiboycott program and the Foreign Corrupt Practices Act (FCPA) are the two examples most often cited, in addition to restrictions on government financing, discussed above. As with other types of restrictions, policy debates about these policies revolve around the question of whether the political principles involved are worth the perceived commercial loss.

The antiboycott provisions of the Export Administration Act are aimed at discouraging and, under certain circumstances, prohibiting, U.S. companies from "taking or knowingly agreeing to take . . . actions with intent to comply with, further, or support any boycott fostered or imposed by a foreign country against a country which is friendly to the United States and which is not the object of any form of boycott pursuant to United States law or regulation." The Office of Antiboycott Compliance (OAC) of the Department of Commerce has enforced the antiboycott program since 1978. In practice, the antiboycott program is directed solely toward reducing the participation of U.S. firms in the Arab boycott of Israel.

The Arab boycott dates from the late 1940's, when the state of Israel came into existence. Administered by the Arab boycott office in Damascus, the purpose of the boycott is to reduce commercial or financial transactions which promote the economic or military development of Israel. Companies trading with Israel are "blacklisted" so that member states are encouraged not to deal with them, but in practice, each nation implements the boycott differently. The Arab countries thus through their boycott of Israel have used trade as a lever in furthering their political goals.

In general, the enforcement of the antiboycott program by the Department of Commerce has been accommodated by many of the Arab nations.[96] Specifically, if the commodity or technology is considered vital for national development, Arab governments have shown flexibility in their application of the boycott. Computerization of the list of boycotted companies and the renewed commitment by nations of the Gulf Cooperation Council to enforcing the boycott lead observers to believe that the boycott may be more tightly enforced in the future.[97] Department of Commerce statistics indicate that Kuwait continues to be the nation from which the largest number of U.S. companies received requests to comply with or support the boycott. More than 35,000 requests reported by U.S. firms during 1982 came from Kuwait; this represents more than 60 percent of the total.[98] Following Kuwait in number of requests were Saudi Arabia, the UAE, Qatar, and Bahrain.

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[95] See Paul Taylor, "U.S. and Japanese Groups Link in Egyptian Nuclear Power Bid," *Financial Times*, Sept. 1, 1983, p. 1. Westinghouse confirmed that it had signed a preliminary agreement with Mitsubishi Heavy Industries to bid for the Egyptian contracts.

[96] Charlotte A. Phillips, *The Arab Boycott of Israel*, CRS 79-215F, May 1979, p. 6.

No other supplier country has a program like the U.S. antiboycott program. While many supplier countries have expressed their opposition to the Arab boycott, none have established antiboycott programs, and only a few have considered enactment of legislation.[99] The U.S. program employs about 30 people. During 1982, the OAC issued 2,500 notices to companies to report and 182 formal warning letters for late reporting. In the same year, the OAC carried out 140 investigations, resulting in the disposition of 43 cases through settlement and involving $548,750. To cite one notable example, in 1983 Citibank was required to pay a fine of $323,000 for failure to report promptly about 337 boycott-related requests. During the past few years, the size of fines awarded and the number of enforcement actions taken by the OAC have increased.

Proponents of the antiboycott program argue that it allows the United States to take a strong stand of nonsupport for discriminatory economic boycotts of friendly nations such as Israel. Most of them question the extent of real trade loss resulting from the boycott and view it as not seriously injurious to the overall trade position of the United States. Citing the fact that American firms retain strong positions in Middle Eastern markets, they argue that commercial damage to U.S. firms has been minimal. In practice, proponents argue, there are many ways to circumvent the boycott, and many firms now trade with Israel as well as Arab governments.

Opponents of the antiboycott program view the situation differently. In their opinion, the fines are a mere indication of sales lost from the boycott. Firms, particularly new-to-market companies, may be discouraged by the legal intricacies of the antiboycott provisions and therefore forego business in the region. In addition, they cite the repeated criticism of U.S. antiboycott policies by governments in the region as evidence of resulting ill will. The difficulties encountered by U.S. firms in complying with antiboycott regulations have reinforced the impression that U.S. policies are restrictive; the result, critics say, is that the United States is viewed as an unreliable supplier.

There is no way to resolve the disputes about the economic impact of the antiboycott program. A number of estimates have been made of trade loss, but it is difficult to separate the effects of the program from other U.S. regulations of trade, such as the Foreign Corrupt Practices Act and the Sherman Anti-Trust Act. In addition, both the Department of Commerce and the Department of the Treasury are authorized under separate statutes to carry out antiboycott policies, the latter allowing for denial of tax benefits to U.S. companies complying with the boycott. Since behavior that is acceptable under the Export Administration amendments may be prohibited under the tax code, the situation is confusing to businessmen. Furthermore, because firms are prohibited from responding to false allegations by foreign governments that they have failed to participate in the boycott, companies have been inaccurately added to the blacklist but unable to protest because of antiboycott provisions. Thus, unmeasurable but real disincentives to trade in Arab nations clearly result from the antiboycott program. On the other hand, firms often have succeeded in circumventing the boycott. In a celebrated case, Arabsat awarded a prime contract to the

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[97] See "The GCC: Tougher Boycott Action," *Middle East Executive Reports*, October 1983, p. 5.

[98] Department of Commerce, *Export Administration Annual Report, 1982*, p. 81.

[99] France has legislation that has not been implemented. A bill has been introduced in the Netherlands.

French firm Ford Aerospatial; the blacklisted U.S. firm Ford Aerospace was nevertheless able to participate as a major subcontractor in the project. While it is impossible to gauge the precise commercial costs, the antiboycott program has, at a minimum, discouraged small firms, particularly smaller new-to-market firms unfamiliar with the intricacies of the program.

The FCPA restricts business activities in all foreign countries and therefore is not uniquely relevant to technology trade with the Middle East. Enacted in 1977, the FCPA prohibits U.S. firms from bribing officials of foreign governments and requires them to keep detailed and accurate records of their transactions. The Securities and Exchange Commission regulates the activities of U.S. businesses abroad under the act. Penalties for violations of the act include corporate fines of up to $1 million, and fines of up to $10,000 and imprisonment of up to 5 years for individuals.

Proponents of the legislation argue that to uphold standards of democracy and fairness, the law is necessary to support foreign governments and to maintain the confidence of the American public in corporate and financial institutions. Those who favor changes in the law point to what they consider to be burdensome recordkeeping requirements and some ambiguity concerning restricted practices. Legislation is currently under consideration in Congress which would amend the FCPA so as to take these criticisms into account.

Despite their considerable criticism of the FCPA, few businessmen have advocated doing away with it altogether. As with the antiboycott program, it is impossible to determine the value of sales lost solely because of the FCPA. During the 5 years of the act's implementation, the Securities and Exchange Commission has prosecuted no bribery cases involving U.S. firms for activities in the Middle East. The Department of Justice has prosecuted one bribery case involving a U.S. firm operating in Qatar.[100] Undoubtedly, the law acts as a restraint on the actions of U.S. businessmen in the Middle East, where payments to agents have often been customary; however, it may well enhance the prestige of U.S. business over the long term by promoting the integrity of American business. The public criticism that arose in Iran in reaction to what was widely viewed as personal aggrandizement by members of the royal family indicates the positive contribution of U.S. laws limiting the involvement of American businessmen in such activities.

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[100] Information provided by the Securities and Exchange Commission, Enforcement Division, October 1983. The case brought by the Justice Department resulted in a civil injunction for actions involving Ministry of Petroleum officials in Qatar.

CONCLUSION

The growth of technology trade with the Middle East during the 1970's occurred despite the fact that U.S. policies have included restrictions not common in other Western supplier nations. There is thus a discrepancy between the fact of growing U.S. economic involvement in the region and official policies, which have had inconsistent and oftentimes inhibiting effects on technology trade.

The primary explanation for the lack of a coherent policy governing technology transfer is that conflicting interests are at stake. There are at least three general perspectives on technology transfer: commercial, development assistance, and military-strategic. Those concerned primarily with promoting U.S. market share and with ensuring the effectiveness of U.S. development assistance programs generally favor promotion of technology trade. In contrast, controls on technology trade have been expanded by those more concerned about restricting access to U.S. equipment and technology by the Soviet Union or nations carrying out terrorist activities and about other actions seen as running counter to U.S. interests.

During the past decade the expansion of controls has been a striking feature of U.S. policies, one which distinguishes American policies from those of other supplier nations.

Many types of government policies and programs indirectly affect technology trade with the Middle East, but none are more significant for setting the overall context than general foreign policies—political and economic. Technology trade, and particularly technology transfer, require long-term interactions between firms and organizations that develop most smoothly in the context of friendly government relations. The strong presence of U.S. firms in Saudi Arabia and Egypt indicates that political and economic interests have converged in setting a context conducive to technology trade. Similarly, policies affecting exchange rates and other international economic policies significantly affect prospects for U.S. exporters.

At another level are various policies--export promotion programs, development assistance programs, and export controls—that more directly affect specific technology trade transactions. It is impossible to quantitatively assess the impacts of these various types of measures on technology trade. In comparison to policies of some other supplier nations, U.S. export promotional programs of certain types have been limited in coverage. U.S. policymakers have been reluctant to engage in high-profile economic diplomacy, routine representation of business has been less extensive, and the United States has not used extraordinary export support programs (such as mixed credits and exchange rate insurance) to the degree that some other suppliers have. OTA's study of technology transfer to the Middle East has identified only a few instances, however, where foreign government programs such as the provision of attractive export credits determined the outcome of contract competition.

U.S. development assistance policies have been important for Egypt and lower-income developing nations in the Middle East, but they have not been strongly oriented toward technology transfer in industrial sectors. While development assistance and commercial promotional programs are generally complementary, U.S. policymakers have been reluctant to link them explicitly.

Export controls have been increased in number and in importance over the years. Nuclear nonproliferation controls have played a critical role in slowing the pace of nuclear weapons proliferation. While there is general agreement that nuclear nonproliferation and national security controls have contributed to the achievement of important political aims, there is disagreement concerning the appropriateness and effects of foreign policy and political controls. In the context of comparatively weak commercial promotion policies, export controls in particular distinguish U.S. policies from those of other Western supplier nations.

Most U.S. policies influence technology trade more directly than they do technology transfer. Only a few programs, such as project reviews by the Overseas Private Investment Corporation and AID programs aimed at promoting technology application and technical manpower development, are specifically designed to promote technology transfer. In practice, technology transfer occurs mostly in the marketplace, and private sector firms rather than the U.S. Government agencies are normally the key players. Corporate strategies directly affect the scope and nature of technology transfer from the United States to Middle Eastern nations. This suggests that if policymakers decide to promote technology transfer, they could emphasize programs involving cooperation with the private sector, which will undoubtedly retain the lead in U.S. technology transfers to the Middle East.

Because U.S. policies affecting technology trade have been characterized by a tension between political and economic interests, no comprehensive policy has been developed. In contrast, other Western suppliers have brought economic interests more to the fore in their export credit and promotion program, and other industrial policies. Options for more consistent U.S. policies are outlined in chapter 15.

CHAPTER 14

Future Prospects for Technology Trade

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CHAPTER 14

Future Prospects for Technology Trade

Will technology trade with the Middle East continue to grow rapidly for the next decade, has it reached a plateau, or will it decline in the remainder of the 1980's and in the 1990's? OTA's analysis indicates that much slower growth of real exports to the Middle East in the period 1985-90 appears likely. This will be on the order of 2 to 5 percent per annum if Middle Eastern countries keep their imports within the bounds of their export earnings. For the decade 1990-2000, it is more difficult to predict trends, but stagnation in real exports seems likely.

In this chapter, OTA assesses prospects for future Middle East technology trade. Two scenarios, involving high and low U.S. export shares, are constructed. While the high export share scenario is theoretically possible, OTA concludes that it is much less plausible than a lower U.S. export share. In light of anticipated slow growth in the volume of overall exports to the Middle East, it is likely that the U.S. export share will decline from the roughly 18 percent share of industrial country exports held by U.S. firms in the past decade.

Politically, the Middle East has been the scene of much international conflict and revolutionary ferment, and political factors will continue to exert strong influence over Middle Eastern technology trade. The potential exists for conflicts that could affect trade as catastrophically as the Iranian revolution or the Iran-Iraq War; such conflicts have generally reduced civilian technology trade. The Arab-Israeli conflict, internal revolutions, great-power tensions, and local wars all have the potential for trade disruption.

The rapidly developing economies of the region have already achieved substantial economic complexity and will continue to develop in the future for two basic reasons: 1) the process under way has already built up a certain momentum, and 2) resources will continue to be provided by the oil sector. On these points economists generally agree, although they disagree about how difficult it will be to make a variety of adjustments which are being forced on Middle Eastern economies by events in the international oil economy and by structural changes in their domestic economies.[1]

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[1] For example, Wharton Econometric Forecasting Associates, *Middle East Economic Outlook*, April 1983; Jahangir Amuzegar, *Oil Exporter's Economic Development in an Interdependent World*, International Monetary Fund, April 1983.

THE VOLUME OF TECHNOLOGY TRADE

In assessing prospects for technology trade, the principal uncertainties concern: 1) what the growth of real oil revenues will be in the coming decade for each of the producers; 2) how much drawdown of foreign investment and use of trade deficits there will be; 3) how the nonoil sector in the Gulf countries will manage the transition from infrastructure development to a more diversified manufacturing economy (or, indeed, if such a transition will be made); and 4) how effective the industrial rationalization programs of Egypt and Algeria and the postwar industrial reconstruction programs of Iraq and Iran may be.

FORECASTING OIL EXPORT REVENUES

The level of Middle Eastern oil revenues will be one of the key determinants of technology trade during the next decade. Forecasting developments in world oil markets and their effects on Middle Eastern oil revenues is an enterprise subject to great error, and OTA does

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not undertake it in this report. Instead, we review several of the basic forces that drive the oil market in order to provide a rough approximation of the likely range of oil revenues of the Middle East.

The oil-exporting countries of the Middle East must determine individually and as part of OPEC how much of their depletable oil resource to ship during any given period to meet national objectives of current consumption and future income growth. Oil left in the ground constitutes a speculation on its future price. Keeping it there does not earn current income, in contrast to selling it and investing the proceeds in interest-bearing bonds or in economic development projects. There is a "capital gain" from leaving the oil in inventory if it will command a higher price when sold in the future. At any point in time, the expected capital gain may constitute an attractive enough return to make keeping the oil in the ground a rational investment decision.

Increases in the real price of oil are, in fact, to be expected in the long run because of the way oil owners attempt to manage their exhaustible asset.[2] The removal of any barrel from the ground increases the value of each barrel remaining there, everything else being equal. From the narrow investment point of view, the production rate of oil should be set so as to increase its value in the ground at the rate that would maximize the expected present value of future returns. When the production rate is optimized in this way, everything else equal, the real price rises, as withdrawals from reserves add value to the remaining reserves. Most actual projections of oil prices, in fact, take this into account and project rising real prices at least in the longer term.

The world is more complicated than the abstract investment model in many different ways, however. Governments must make decisions about what fraction of oil revenues to allocate among current consumption, foreign investment, and domestic capital formation. How the benefits are distributed among various groups of the population is invariably a key element in domestic politics and therefore enters the decision process. The international political dimensions are also important because countries use their oil wealth to gain international power and prestige and to develop military strength.

At least for particular member countries, OPEC production decisions are also an important determinant of production rates. Such production rates are the subject of negotiation within the cartel, and governments take them very seriously. Iran, for instance, despite the bitter war, continues to participate fully in OPEC along with Iraq and its Arab allies. How much impact OPEC has on overall production and prices in the long run, however, is subject to debate, since actual production rates differ substantially from those agreed on.

On the demand side, important factors that must be taken into account in making forecasts of prices and production rates in the next decade are: first, the delayed effects of the 1979 oil price rise on the miles-per-gallon characteristics of the stock of transportation vehicles and the efficiency of stationary industrial energy uses (in other words, conservation); and second, the rate of economic growth in the industrial countries.[3]

A number of forecasting groups have recently attempted to take all these elements into account and make medium- and long-term oil price and production forecasts. Table 113 lists a selection of forecasts made in 1983 by various energy forecasting groups and compiled by the Department of Energy (DOE).[4] Most

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[2] For classic references on the economics of exhaustible resources, see Harold Hotelling, "The Economics of Exhaustible Resources," *Journal of Political Economy*, vol. 39, April 1931, pp. 137-175; and Robert M. Solow, "The Economics of Resources and the Resources of Economics," *American Economic Review*, vol. 64, May 1974, pp. 1-14.

[3] Estimates of the changes in transportation energy use efficiency and price and income elasticities of transportation energy demand for the United States are presented in Douglas L. Adkins, "Forecasting Transportation Demand for Petroleum: A New Generation of Econometric Models of Highway and Airline Industry Fuel Use," paper presented to the Transportation Research Board, National Research Council, January 1983.

[4] Department of Energy, Office of Policy, Planning, and Analysis, *Energy Projections to the Year 2010*, October 1983, tables 7-10, 7-11.

Table 113.—1983 Projections of the International Oil Price and OPEC Oil Production
(1982 dollars per barrel or million barrels per day)

Date forecast published	Forecasting group	1990		2000	
		Price	OPEC production	Price	OPEC production
6/83	Department of Energy, National Energy Policy Plan Scenario B	$32	26	$57	28
4/83	Energy Information Administration, Annual Energy Outlook Middle Scenario	37	27	59	—
2/83	Data Resources Inc.	36	26	51	—
6/83	Manne and Preckel, Stanford	36	23	58	25
2/83	Oil Company B	—	26	—	30
6/83	Oil Company C	—	21	—	27
2/83	Oil Company D	—	23	—	28
4/83	Chase Econometrics	34	—	42	—
4/83	Wharton Econometric Forecasting Associates	35	—	—	—
4/83	American Gas Association	37	—	45	—
1/83	Energy Study Centre	53	—	64	—

SOURCE: Department of Energy, Office of Policy, Planning and Analysis, *Energy Projections to the Year 2010*, October 1983, tables 7-10 and 7-11. See this source for a listing of the publications in which the above forecasts appeared.

of the projected 1990 price forecasts fall in a narrow region of around $35 per barrel (1982 dollars), and most of the 1990 OPEC production forecasts are approximately 25 million barrels per day (b/d), ±2 million b/d. This range of forecasts is consistent with those of the International Energy Agency (IEA), which we used to make forecasts of Middle Eastern oil export revenues (table 114).

The record of the past 12 years leads us to be skeptical about all oil market forecasts. They are based on stated and unstated assumptions that are subject to change. For instance, the 1982 price forecasts for 1990, which are cited in the DOE report referenced above, are generally considerably higher than those published in 1983. The 1982 price softness in the oil market was the occasion for

Table 114.—Projected Middle East Oil Export Revenue[a]

	1980	1983	1985	1990	1995	2000
Real oil price (1982 dollars):						
High revenue scenario[b]	$36[c]	$28[c]	$32[d]	$37	$43[e]	$49
Low revenue scenario[f]	36[c]	28[c]	30[d]	30	30[e]	30
Middle East oil exports (million barrels/day):[g]						
High revenue scenario	19[c]	10[c]	16[d]	18	16[e]	14
Low revenue scenario	19[c]	10[c]	18[d]	20	21[e]	22
Middle East oil export revenues (1982 dollars, billions):						
High revenue scenario	$250	$102	$187	$243	$250	$250
Low revenue scenario	250	102	197	219	230	241
Change in real revenues (percent per annum, average)	80-83%	83-85%	85-90%	90-95%	95-2000%	
High revenue scenario	-29.9%	+30.3%	+5.2%	+ .6%	0%	
Low revenue scenario	-29.9%	+32.9%	+2.1%	+1.0%	+0.9%	

[a] Middle East members of OPEC: Saudi Arabia, Iraq, Iran, Algeria, Kuwait, United Arab Emirates, Qatar, and Libya. The IEA projections of Middle East OPEC's share of total OPEC production were in the 78 to 81-percent range for the period.

[b] OTA's high oil revenue scenario is the same as IEA's low demand scenario: combines low world economic growth and high oil price assumptions that in combination result in relatively low demand: world economic growth—2.4 percent to 1985, 2.7 percent thereafter; real oil price—increase at 3.0% per annum after 1985.

[c] Actual price and output. Dollar magnitudes converted to 1982 dollars using the GNP deflator. (Source: CIA, *International Energy Statistical Review*, June 26, 1984, pp. 2-3, 19.) Estimated exports of natural gas liquids added. (Source: *Middle East Economic Digest*, June 29, 1984, p. 15.)

[d] IEA's 1985 projections assume full European recovery from the recession. Since this may not characterize all of 1985, they may be better interpreted as indicating the rate of exports and the oil price when recovery is complete, rather than a forecast for calendar year 1985.

[e] Interpolated.

[f] OTA's low oil revenue scenario is the same as IEA's high demand scenario: combines high world economic growth and low oil price assumptions that in combination result in relatively high demand: world economic growth—2.6 percent to 1985, 3.2 percent thereafter; real oil price—constant after 1985.

[g] Includes natural gas liquids. Inventory changes are not considered. Derived from IEA projections of OPEC production under the low and high demand scenarios, except that for 2000, IEA's estimate of the production under a "maximum sustainable capacity" scenario (33 million b/d) is substituted for high demand estimate of 28 million b/d. If OPEC production should be only 28 million b/d, Middle East oil revenues would decline by 1.6 percent per annum in 1990-2000.

SOURCE: Based on International Energy Agency, *World Energy Outlook*, Organization for Economic Cooperation and Development (Paris: 1982), pp. 23-26, 80, 460-461. Dollar magnitudes converted to 1982 dollars using the GNP deflator (table B-3, Economic Report of the President, March 1984).

forecasters to rethink their approaches to the forecasting problem, and they tended to move together in revising their forecasts downward.[5] Although this tendency for forecasts to change as the current price of oil changes may stir skepticism, recent forecasts nevertheless represent the best current professional thinking.

With this caution in mind, OTA uses the IEA projections of world oil supply, demand, and price for 1985, 1990, and 2000 under two scenarios that combine plausible economic growth and oil price assumptions that would together produce high demand for oil, on the one hand, and low demand, on the other.

Table 114 contains historical data and presents projections of Middle Eastern oil export revenues based on IEA's two scenarios. After quintupling from 1973 to 1980,[6] Middle Eastern real oil export revenues fell precipitously from 1980 to 1983 (at an annual average rate of 30 percent). Real 1983 revenues were only 41 percent of those of 1980.

OTA does not expect revenues to persist at this depressed level, however. Based on the IEA projections, OTA expects them to return to within the $185 billion to $197 billion per annum range by sometime in 1985, when the European economic recovery is complete. The rapid growth of revenues during this recovery period will reduce short-term pressure on the balances of payments of Middle Eastern countries. All forecasters expect rapidly increasing revenues to to be only temporary, however—a reflection of the world economic recovery.

A new era of slow growth or even slight decline of Middle Eastern oil revenues is expected to begin in the period beyond 1985 once recovery from the world recession has been completed. Even under the high revenue scenario, real export revenues in 1990 ($243 billion) recover only to the 1980 level, staying roughly constant at that level through 2000.

Under the low revenue scenario, Middle Eastern oil export revenues never again reach the 1980 level. They increase slowly at 2 percent per annum during the 1985-90 period and even more slowly (at less than 1 percent per annum) during the 1990's.[7]

In summary, OTA's Middle Eastern oil revenue projections can be stated as follows:

- Vigorous near-term growth of revenues as economic recovery in the industrial countries takes place; real revenues, nonetheless, remain below the level of 1980.
- Slow growth in revenues from 1985 to 1990 at 2 to 5 percent per annum.
- Stagnation in the 1990-2000 period.

IMPACT ON TRADE

If exports of goods and services from the industrial countries to the Middle East grow relatively slowly, in the 2 to 5 percent per annum range that appears likely to be financed by oil exports from the Middle East, the new trade era will be completely different from that recently experienced. The contrast can be seen when one considers that Saudi Arabia's and Iraq's imports grew at over 25 percent per annum during the 1973-82 period (table 13, ch. 4), and that both Egypt's and Kuwait's grew at 17 percent per annum during the same period.

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[5] For a worldwide survey of approximately 200 projections of the international oil price and of interregional oil and gas exports, see Alan S. Manne and Leo Schrattenholzer, "International Energy Workshop: A Summary of the 1983 Poll Responses," *The Energy Journal*, January 1984, pp. 45-54. Most of the projections reported in this article were done in the years 1981-83 and few are derived directly from formal models. Between the 1981 and 1983 polls, the median oil-price projection for the year 2000 declined 18 percent (p. 51). For a historical analysis of how U.S. energy projections made since 1950 for years in the 1980's have changed over the period, see DOE, op. cit., ch. 7.

[6] Derived from the sources cited in table 120. This growth in real revenues can be expressed as an average annual rate of 22.5 percent. The revenue increases, of course, occurred mainly in 1973 and 1979 and real declines occurred in other years.

[7] In IEA computer simulations, the economic growth and price assumptions are somewhat inconsistent in the 1990's. This is particularly evident in the high demand (low revenue) scenario, as the IEA points out, since the projections were based on the assumption that policies are unchanged. Changes in policies are, of course, difficult to forecast, but the IEA has also devised a reference set of plausible policy changes to promote inter-fuel substitution that would eliminate excess demand for oil in the 1990's at the scenario prices. An implicit assumption of the IEA high demand scenario, which OTA believes to be plausible enough to construct the scenario, is therefore that the prospect of higher oil prices will induce policy changes or conservation that, in absence of a serious supply disruption, will prevent prices from rising beyond the indicated levels. On the supply side, we use IEA's "maximum sustainable capacity" scenario in 2000 to indicate our belief that, given declining prospective oil revenues, Middle Eastern countries might attempt to increase production beyond the previously targeted levels and that this more plausibly sets an upper bound than IEA's low demand scenario for that year.

Certain Middle Eastern countries have the option of increasing trade at a rate much greater than the rate at which oil revenues increase because large trade deficits can be financed out of foreign investment earnings, by a drawdown of the investments themselves, or by credit based on investments. Nevertheless, in an era when Middle Eastern oil exports are growing slowly, it is unlikely that imports would grow at the phenomenal rates of the past.

The Middle Eastern oil exporters have recently demonstrated their ability to undergo massive current account deficits. The Middle East, as a whole, experienced a current account deficit of $12 billion in 1983, and the International Monetary Fund forecasts a deficit of like amount in 1984.[8]

Whether or not the Middle Eastern oil exporters are "willing" to undergo such deficits is another question. Wharton Econometric Forecasting Associates expects the Saudi deficit to disappear in 1986.[9] If so, it will be the combined effect of the world recovery and the determination of the Saudi Government to live within current resources.

Assuming that total imports of Middle Eastern countries over the next decade will be constrained by the growth of exports just as they are for most countries,[10] annual imports will be likely to grow 2 to 5 percent per year until 1990 and then stagnate or possibly decline thereafter.

THE EFFECT OF OTHER SCENARIOS ON TRADE

OTA also considered the possibility of vastly different scenarios of oil prices and revenues and attempted to assess their impact on imports into the Middle East. A disruption scenario, such as the closing of the Strait of Hormuz or a revolution in Saudi Arabia, is a possibility. Since the world oil market is in a glut, and important non-Gulf producers, such as Nigeria, Mexico, and Libya, are standing by with excess capacity, such a disruption might have less of an impact on the price of oil than it would have had in earlier periods of market tightness.

Nevertheless, disruption in the flow of oil from the Gulf could lead to a substantial increase in the price of oil, which would depend on the size of the actual loss of supply.[11] This would reduce revenues of the disrupted countries but increase revenues of other Middle Eastern exporters.[12] What the net effect would be would depend on the characteristics of the disruption and the impact on the oil price, but a disruption in the Persian Gulf could negatively affect oil exports from four of the countries of major concern in this study—Iran, Iraq, Kuwait, and Saudi Arabia.[13]

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[8] International Monetary Fund, *World Economic Outlook*, Washington, D.C., 1984, table 17, p. 187.

[9] Wharton Econometric Forecasting Associates, *Middle East Economic Outlook*, April 1983, p. 111.

[10] This is not to suggest a lock-step relationship between export earnings and the ability to import. Countries can finance trade deficits in a number of ways; nevertheless, for most countries export earnings are the principal source of ability to import. We should note that Egypt and Kuwait are partial exceptions to this. Egypt's import growth will also depend substantially on the growth of development assistance. For Kuwait, investment income will be of roughly equal magnitude to oil revenues, and growth in investment income will support growth in its imports.

[11] A major oil industry executive sees the political situation in the Middle East as the one thing that could have a dramatic effect on the world oil market. *New York Times*, Sept. 12, 1983, p. D1. See also, Congressional Research Service, "Western Vulnerability to a Disruption of Persian Gulf Oil Supplies: U.S. Interests and Options," Mar. 24, 1983; and U.S. Congress, Office of Technology Assessment, *Strategic Responses to an Extended Oil Disruption*, forthcoming, 1984.

[12] We assume in the discussion that follows that both the short- and long-run price elasticities of demand are substantially less than one, so that an increase in price results in an increase in revenues and vice-versa.

[13] A disruption scenario involving non-Middle East developing-country producers, notably Mexico, Nigeria, Indonesia, and Venezuela, can also be constructed, but the potential impact of a disruption of any single country among them on the world oil economy during the next decade is limited. IEA expects all such countries together to produce only about one-fifth of world oil supply in 1990, of which about one-third would be produced by Mexico. A full disruption of Mexican supply would have sig-

A scenario of a fall in revenues owing to a large fall in the price of oil is also possible, although it is difficult to estimate how likely it is. This scenario would be based on the judgment that the current price of $29 per barrel (1984 dollars), which is under market pressure at present, is not sustainable in the intermediate future, even with world economic recovery.[14] Such a judgment depends in turn on other judgments about a number of fundamental questions, such as whether OPEC really has the power to effectively determine total world output and the international oil price and whether large new low-cost producers might appear on the scene.

If the $29 price should fall significantly, because OPEC loses power or for another reason, oil revenues would fall substantially in the short run. If the inevitable long-run increase in the real price of oil from that level should also be held off by large new low-cost production being placed on the market at the lower price, the low price and revenues could persist through the next decade and beyond.

Neither of these widely divergent scenarios on the oil price would lead to **total** Middle Eastern oil revenues growing as rapidly in the future as they did in the 1970's. In the disruption scenario certain Middle Eastern countries would stand to increase revenues, but others would stand to lose. In the low-price scenario, all exporters would lose, and total Middle Eastern oil revenues would decline.[15]

Thus, one is left with a reasonably strong conclusion, taking into account the unlikely scenarios, that Middle Eastern oil revenues are unlikely to increase rapidly in the next decade. Such slower revenue growth is also likely to result in slowly growing Middle East imports from the industrial countries.

One implication of a new foreign exchange constraint on imports in capital-surplus countries is that Middle Eastern policymakers will have to face explicitly the tradeoffs between imports of consumer goods, raw materials, and capital goods for the first time in a decade. If machinery and equipment imports increase at a higher rate than total imports, imports of consumer goods and raw materials would have to increase at lower rates or might decrease.

The mechanisms for limiting imports in the face of limited oil revenues are basically two: a decline in the value of the currency, which makes imports more expensive and therefore less demanded, or a foreign exchange allocation scheme that politically and/or administratively determines who will be given the right to import. A marked reduction in imports of consumer goods, with or without large increases in their prices, would probably have unpleasant political ramifications that governments may not be prepared to shoulder. The unexpected slowdown in foreign exchange growth, therefore, brings a new and unpredictable politics of distribution among competing uses and groups.

THE IMPACT OF CHANGING ECONOMIC STRUCTURE ON TECHNOLOGY TRADE

The economic structure of the oil-exporting countries of the Middle East appears to be changing in several ways that will affect technology imports. The emphasis on investment in infrastructure[16] projects that has characterized the economic development and technology transfer activities, particularly, of the capital-surplus countries is starting to give way to a new phase in which more official emphasis is being placed on the development of the

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nificant impact on world oil prices and would increase Middle East oil export revenues, all else equal, but estimating this impact is beyond the scope of the present study.

[14] Significant real oil price declines in 1984 are indicated in an article on the international oil market (*New York Times*, July 7, 1984, p. 36) and add plausibility to this scenario.

[15] See footnote 12.

[16] Infrastructure refers to the type of economic activity that directly or indirectly provides generalized inputs, usually services, for other enterprises. Physical infrastructure is conventionally defined to include transportation, communications, power, water, and gas services. Social infrastructure, a looser term, is usually used to refer to education, health, and the legal/regulatory apparatus of the society. Once defined as infrastructure, the service involved is usually measured in toto, whether or not it is provided to enterprises or to consumers directly.

manufacturing sector. In this transition, technology transfer will be increasingly important.

Continued Infrastructure Development

It would be a mistake to conclude that infrastructure development will not continue; the contracting emphasis may shift, however, to smaller and more specialized firms, with local firms playing a greater role.[17] Each of the countries OTA has examined now has a large domestic construction industry. In Saudi Arabia, for example, the construction industry (foreign and local firms participating) has been making a contribution to gross domestic product (GDP) more than four times the contribution of the manufacturing sector.[18]

Kuwait continues to place heavy emphasis on telecommunications development. In Algeria and Egypt, considerable force seems to have developed behind continued airport expansion. In Iran and Iraq, destroyed or postponed infrastructure investments of all kinds may give rise to large new construction projects after the war. All countries continue to invest heavily in social infrastructure sectors such as medical services and education.

Considering the infrastructure projects already completed or under way in the region, operations and maintenance requirements for existing projects will also be a growing source of demand for technology imports. Thus, for many different reasons, including domestic politics, infrastructure development will continue to be a stimulus for large imports of machinery and technologies even if the manufacturing sector begins to grow more rapidly in many Middle Eastern countries.

The Expanding Manufacturing Sector

The expanding Middle East manufacturing sector will be a second important source of demand for technology imports in the next 15 years. All countries except Kuwait currently place substantial emphasis on official plans for the development of their manufacturing sectors, but they start from different positions.

In Saudi Arabia and the other capital-surplus countries of the Gulf the desired development of the manufacturing sector must expand from a small base. In Egypt, which already has a sizable, diversified, but inefficient, manufacturing sector dominated by public enterprises, the government seeks to rationalize and reinvigorate it. In Algeria, Iraq, and Iran, all of which have smaller, but also inefficient, manufacturing sectors, the empha-

Photo credit: Middle East Economic Digest

Mercedes plant in Saudi Arabia

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[17] According to the *Middle East Economic Digest*, the share of contracts awarded to local and other Middle East firms rose to a high of 22.9 percent of the total across all sectors in 1982 before declining to 15.6 percent in 1983. See *Contracts Awarded, Second Half, 1983*, p. 15. In March 1983, Saudi Arabia issued a royal decree requiring that foreign construction companies subcontract 30 percent of their work to Saudi firms.

[18] Wharton Econometric Forecasting Associates, *Middle East Economic Outlook*, April 1983. The "manufacturing" sector includes a small nonpetroleum mining component.

sis (post-Iraq-Iran War) will probably be on both renovation and expansion.

Despite the desires of planners, there is substantial uncertainty about how large machinery and technical services imports will be for Middle East manufacturing. The existing small manufacturing sectors of Saudi Arabia and Kuwait will probably maintain their current modest momentum of growth. (Real manufacturing output was growing at about 6 percent per annum in both countries in the early 1980's.[19]) But imports of technology to support continued growth at this rate would not result in a surge of technology trade in the next decade comparable to what infrastructure development produced in the last. Manufacturing growth would have to be much faster to boost the demand for technology imports in the manufacturing sector into a large fraction of the total.

Looking at the case of Saudi Arabia—by far the major U.S. trading partner in the region—a number of considerations are involved in whether Saudi Arabia will develop a manufacturing sector rapidly enough to generate a significant demand for equipment and technical service imports in the next decade.

The first consideration is technology absorption. Obstacles to absorption, discussed in chapters 2 through 10, are particularly pertinent to the development of the Saudi manufacturing sector. Manufacturing firms generally require greater adaptive technological capability than infrastructure enterprises do, and they also require marketing skills necessary to appeal to customers who usually have alternatives to any given company's manufacturing output. In relatively open economies, firms engaging in import substitution must be able to face competition from abroad. One critical area of uncertainty is whether technical and entrepreneurial skills will be adequate to meet these challenges.

A second consideration affecting how rapidly the Saudi manufacturing sector will grow is whether other competing demands for foreign exchange will give way to demands from this new sector to finance technology and raw material imports. Perhaps the greatest unknown would be whether a primarily private nonoil manufacturing sector could compete successfully for scarce foreign exchange with government-led social and physical infrastructure projects.

Third, in an era of greater foreign exchange scarcity, the riyal exchange rate is likely to decline, and this would have a number of effects. The most powerful, perhaps, would be an increased incentive to manufacture import substitutes, since competing foreign goods would now be more expensive. To be sure, so would the imported inputs of the new manufacturing enterprises, but since the government currently subsidizes the local inputs of Saudi manufacturing enterprises—for instance, through subsidized credit and energy prices—a decrease in the exchange rate would undoubtedly still constitute a powerful incentive to expansion.

Fourth, import-substituting enterprises may be able to convince the government to protect them with tariffs and other trade barriers. Such measures might lure erstwhile foreign exporters to Saudi Arabia to set up local manufacturing enterprises. The relatively small Saudi domestic market for many commodities, however, would still limit investment opportunities.

Despite all the uncertainties, however, the Saudi manufacturing sector is likely to generate a growing, if initially moderate, demand for technology transfer and trade. By the end of the next decade, even a moderately fast-growing manufacturing sector (say, 7 percent per annum) would double its current size and probably its imports.

Many of these observations apply in somewhat different form to other Middle Eastern countries. In Egypt, a relatively large and diversified manufacturing sector has been generating significant technology trade. The question about Egypt's manufacturing sector is whether recent changes in economic policy will allow it to continue to expand. Considering that Egypt's industry is primarily in the public sector and that foreign investors have yet to enter the "open door" in any numbers, the chances of continued rapid expansion of the manufacturing sector in the future would not seem bright. It cannot be ruled out, however. Despite long-standing conditions of bureaucratic inefficiency, Egypt's manufacturing sector has been expanding relatively vigorously by world standards (10 percent per annum in real terms in the last few years).[20]

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[19] Wharton Econometric Forecasting Associates, op. cit., tables 5.3 and 6.2.

Algeria, Iraq, and Iran have significant but not highly developed manufacturing sectors, which, however, are well behind Egypt's in size and diversification. They are likely to generate fairly rapidly growing technology imports in the next decade, if the war between Iran and Iraq is concluded, since manufacturing is being emphasized in current economic planning.

It should be emphasized that even if the manufacturing sector does not develop as rapidly as it might, the Middle East will continue to constitute a large market for technology trade, as continuing investment is made in physical and social infrastructure and in other service sectors. A burgeoning demand for manufacturing technology is likely to be satisfied at the expense of infrastructure rather than at the expense of military or consumer imports, in the context of the relative foreign exchange scarcity that we have forecast, in light of the political sensitivity of military and consumer imports. In the converse situation—low growth in manufacturing—imports for infrastructure investment will be likely to take up a good deal of the slack, and the Middle East will remain an important market for Western technology. While the substitutability between manufacturing and infrastructure demand for imported technology will tend to maintain the volume of technology imports, the composition will vary depending on the relative importance of manufacturing.

PROSPECTS FOR SUPPLIER SHARES

SHARE TRENDS

With the exception of a noticeable improvement in the Japanese share and a distinct fall in the French share, most supplier country export shares to the Middle East were relatively stable during the past decade. In the context of rapid economic expansion and political turbulence, this was somewhat surprising. Although there was some fluctuation, the shares of four of the six supplier countries were approximately the same in 1982 as they were in 1970 (see ch. 4, tables 26 to 31). With two-thirds of the U.S. share concentrated in Saudi Arabia and Egypt, however, there can be little confidence in mechanically projecting a constant U.S. share based on this trend.

Neither does it appear likely that the trends identified in the French and Japanese shares can confidently be projected into the future. The French share in Algerian exports has reached the point where it is unlikely to drop as rapidly as in the past, or even drop at all. The worldwide share of Japanese exports in less developed countries (LDCs), which has generally been increasing for two decades, might now level off as the newly industrializing countries become more competitive in manufactured goods with standardized technologies.[21] Thus, continued rapid increase in the export share of Japan over the long run is probably not to be expected, although it is by no means improbable.

In order to establish the range of possible variation in U.S. export shares to the Middle East market, OTA has organized the discussion around two scenarios. Based on an examination of past trends, quantitative high and low export scenarios are constructed. Underlying these are assumptions about the effect of politics (and other factors) on patterns of technology trade.

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[20] Wharton Econometric Forecasting Associates, op. cit.

[21] See Raymond F. Mikesell and Mark G. Farah, *U.S. Export Competitiveness in Third World Markets* (Washington, D.C.: Georgetown University, 1980). See table i.1, p. 7, for share data for Japanese exports to LDCs.

On the one hand, prospects for expansion of supplier shares are limited by the desire of Middle Eastern nations to diversify suppliers for economic as well as political reasons. As discussed in chapter 6, for example, Algeria consciously sought to reduce dependence on France during the past decade. While the upper bound to supplier shares in a particular Middle Eastern country market is difficult to quantify, the existence of such an implied upper bound even when political relations between supplier and recipient are strong leads to the conclusion that it is highly unlikely that the United States will expand its position very much in either Saudi Arabia or Egypt.

On the other hand, if political relations between supplier and recipient are severely strained, the supplier is unlikely to win or maintain an overwhelming share of the market. The sharp decline in trade between the United States and revolutionary Iran illustrates the negative effects of political disputes on trade. Persisting political hostility between supplier and recipient, it is hypothesized, will eventually preclude a large supplier share. However, the record of the past decade indicates that this assumption must not be interpreted too rigidly. The United States and Libya were major trading partners until the early 1980's. In addition, countries such as Iraq which have not always supported U.S. political and diplomatic positions have preferred Western, and in some instances U.S., technology. Over the course of a decade, however, overt political hostility between recipient and supplier can be expected to limit the supplier's shares.

HIGH U.S. EXPORT SHARE SCENARIO

The U.S. market share in exports to the Middle East is strongly dependent on high individual shares for Saudi Arabia and Egypt. In both of these countries, the United States has a higher market share than Japan and West Germany, the two principal competitors of the United States in the region. In contrast to the United States, neither Japan nor West Germany has taken a strong political position in the region nor attempted to couple foreign policy with trade policy.

It is possible to quantify an illustrative high-share scenario for the United States based on an assumption that the United States share equals the 1982 share of Japan, West Germany, or the United States—whichever was highest—in each Middle Eastern country. Thus, the United States keeps its (high) shares of the Saudi Arabian and Egyptian markets; takes on the German share in the Iran, Iraq, Libyan, and Algerian markets; and assumes the Japanese share in Kuwait and the Gulf kingdoms. (See table 32 for the 1982 country share data.)

Applying these assumptions to 1982 exports, the United States' overall Middle Eastern share would have been 32 percent of the total exports of the six major industrial countries rather than 22 percent.[22] This would appear to set an upper bound to what the U.S. share might become in the next decade under greatly improved performance in all countries where the United States did not have the larger share. In 1982 this superior performance would have increased U.S. exports by $7 billion over the $19.8 billion actually realized, and U.S. exports to the Middle East would have increased from 16 to 22 percent of exports to all LDCs.

The question is whether there is a set of events that might make the high market share scenario come true. First and most important, the United States would have to maintain its preeminent share in Saudi Arabia and Egypt.

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[22] Note that these supplier share percentages (and most others cited in this chapter) are based on calculations including only the six major Western suppliers, and do not include total industrial country exports. To be specific, the 22 percent U.S. share was derived from the data in table 26 as follows: the U.S. share of total industrial country exports to the Middle East—17.9 percent—is 22.2 percent of the 80.5 percent total for the six major industrial countries.

This, however, is somewhat unlikely. One reason for the U.S. preeminence in Saudi Arabia was the existence in the late 1970's and early 1980's of the "mega" construction projects, where the United States had a comparative advantage in technical and managerial services. In an era of foreign exchange limitation (by Saudi standards) and growing buyer sophistication, the proportion of smaller unbundled construction projects will probably increase and will probably result in a smaller share for U.S. contractors.

Furthermore, if it follows the general pattern in the Middle East, Saudi Arabia will lessen its dependence on a single supplier. In Egypt, a policy that explicitly links aid policy to commercial policy could theoretically result in an expanded U.S. market share, especially of machinery and equipment imports (see table 100 in ch. 12). However, this seems unlikely in view of Egypt's steps toward rapprochement with the other Arab countries and concerns about dependence on the United States.

The high shares of Japan and West Germany in certain countries probably result in part from their ability to stay aloof from Middle Eastern politics. However, it seems unlikely that the United States could similarly disengage itself from Middle Eastern politics without suffering considerable political costs, even if it desired to do so for commercial policy reasons. Therefore, it is unrealistic to expect that the United States might obtain the "nonpolitical" maximum share in all countries.

If foreign economic policy were given more emphasis, however, it might be possible to increase the U.S. share slightly. Even if foreign policy disengagement is not vigorously pursued as an across-the-board policy, policymakers might decide to decouple trade from foreign policy in a few specific cases. For example, if a conscious decision were made to do so because of changed political or other circumstances, nations such as Iran, Iraq, Syria, and Libya, which have not been closely allied with U.S. diplomatic positions, could become stronger trading partners.

Since it is not clear how much effect controls and antiboycott/corrupt practices policies have had on the U.S. market share independently of broader foreign policy, the magnitude of any decoupling effect is uncertain. OTA's judgment, based on subjective evidence, is that decoupling would have a small but significantly favorable effect on U.S. market share. Likewise, expanded efforts to represent U.S. business in the Middle East, including high-level support, as well as improvements in the foreign commercial service, might improve U.S. export performance by a small amount.

An end to the Arab-Israel conflict would extricate the United States from the unhappy situation of trying to be friends with those at odds with one another. The effect on exports is hard to determine, however. Where exports from the United States have been reduced because of the conflict, the United States would gain; where a strong political position has resulted in a high export share and where this strong position would dissipate with Arab-Israeli peace, the United States might lose its share. On balance, there would probably be opportunity to expand the U.S. share.

The U.S. market share would also tend to increase if international trade agreements reduced "unfair" export competition by other countries. For instance, if the new interest-rate provisions of the Organization for Economic Cooperation and Development (OECD) arrangement on officially supported export credits lead to less subsidization of exports by other suppliers, as they appear to be doing,[23] all three of the major suppliers may benefit, since neither West Germany nor Japan use large amounts of subsidized export credit. Regarding Egypt and Algeria, all suppliers have used aid and mixed credits in connection with exports, so it is not clear what impact a possibly emerging international agreement on mixed credits would have on the U.S. share of Middle East trade.

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[23] The Export-Import Bank stated in its *1983 Annual Report* that the new provisions "will phase out most remaining export credit subsidies by July 1986," p. 4.

All in all, the improved international trade rules that might be obtained would probably have only a minor effect on market share in the Middle East, because it seems unlikely that they could be tightened enough to fully hamstring those supplier governments intent on helping their exporters—and because the aid/trade connection will always exist.

Currency realignment would probably be relatively powerful over a period of time in changing the U.S. export share in the Middle East. If those who think that the dollar is substantially but temporarily overvalued compared to the yen and the mark are correct, U.S. exports in the Middle East and elsewhere could receive a significant price-effect stimulus in the future.

In the last analysis, basic changes in the comparative advantage of U.S. exports[24] and in the economic growth rate of the United States will probably be the most important economic factors determining the U.S. export share in the Middle East—as they will be in worldwide trade. Long-run changes in comparative advantage in the international economy are virtually impossible to predict, however. The leading industrial economies may become more similar, or the United States may keep its comparative advantage in exports that depend heavily on research and development and highly skilled professionals.

To sum up, the factors that could raise the U.S. export share, which are specific to the Middle East, appear to be either not very likely or not very powerful. Those which could raise the long-run worldwide U.S. export share, including its share of exports to the Middle East, exceptionally fast U.S. economic growth throughout the period or shifts in comparative advantage, are together unlikely to raise the U.S. share more than a few percentage points except possibly in the very long run. The fundamental change in the relation of the United States to the international economy that would have to occur for the United States to have a materially larger export share worldwide because of these two long-run factors is probably not likely to occur, and it is certainly not predictable with any confidence. This leaves currency realignment as the factor most likely to give a material upward boost—on the order of a few percentage points—to the U.S. export share in the Middle East and elsewhere.[25] Taking all these factors together, it does not appear likely that there will be a large increase in U.S. market share in the Middle East.

LOW U.S. EXPORT SHARE SCENARIO

On a more pessimistic note, a low-export share scenario can be quantified on the arbitrary assumption that U.S. firms receive the lowest shares of the three major Western exporters. Under this assumption the United States would keep its 1982 share of exports to Iraq, Iran, Syria, and the Yemens; it would take Japan's share of Egypt, Algeria, Libya, Jordan, and Lebanon; and West Germany's share of Saudi Arabia, Kuwait, and the Gulf kingdoms. For 1982, the resulting U.S. Middle Eastern export share would have been only 10.8 percent of the six major industrial country total, rather than the 22 percent it actually was. This less satisfactory performance would have decreased U.S. exports by $9 billion, and exports to the Middle East as a share of exports to all LDCs, all else remaining the same, would have decreased from 16 to 8 percent.

In fact, such a precipitous fall in market share could result simply from reducing the U.S. share of exports to Saudi Arabia and Egypt to the levels of the other two major competitors. To demonstrate how dependent the overall U.S. share is on its high shares of exports to its major Middle Eastern trading partners, the following possibility is considered: if the United States had the West German share of exports to Saudi Arabia and the Japanese share of exports to Egypt, and maintained its export share at the actual share level it had in 1982 for the other 13 countries, its regional share would have been only 12.4 percent of the total for the six major industrial countries in 1982, which is comparable to its share under the low export share scenario, and far lower than its actual share of 22 percent.

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[24] See ch. 2 for a brief discussion of this concept.

[25] As an indication of how much difference a decrease in the value of the dollar could make, if the long-run price elasticity of the U.S. six industrial country export share was in the range of 0.5 to 1.0 (moderate sensitivity), the increased export share that would be induced by a 10 percent drop in the value of the dollar would be 1 to 2 percent.

Since such a high fraction of U.S. exports to the Middle East goes to Saudi Arabia, any factors that would lower either Saudi Arabia's total imports more than those of other countries in the region or would lower the U.S. share of Saudi imports would be likely to reduce the U.S. regional share. Slower growing Middle East oil revenues in the 1980's and 1990's, and hence slower growing exports to the region, are, in fact, likely to affect Saudi Arabia disproportionately in absolute magnitude, since its import growth was so rapid in the 1970's. If exports to Saudi Arabia become a smaller fraction of total exports to the Middle East, all else equal, a smaller U.S. share will result.

It is not unlikely, furthermore, that the U.S. share of the Saudi market will decline, for a number of reasons. With the passing of the "mega" project era, an area of particular U.S. comparative advantage may also have passed. If it wasn't comparative advantage but politics or established position in the Saudi market that resulted in a U.S. export share 36 percent higher than Japan's in 1982, any dissipation in these latter factors would also be likely to result in a regression of the U.S. market share toward those of its major competitors. An active policy by the Saudi Arabian Government to reduce its dependence on any one supplier could have the same effect.

Diversification could result from either dissatisfaction with U.S. policy in the region, or the desire to improve bargaining position by increasing competition among potential suppliers. Saudi use of trade as a weapon against the United States, during a period of rough bilateral relations, could be even more damaging to the U.S. share. On the U.S. side, a widening of national security controls to limit the export of technologies having both civilian and military uses would tend to reduce the U.S. share.

Finally, regime change or political instability would raise the possibility of a full break in relations similar to the break with Iran (and for the same reasons), which in the latter case resulted in a current U.S. market share one-tenth that of its share of the Saudi Arabian market.

Considering all these possibilities, together with the competition from other firms for Saudi Arabian sales, OTA judges it to be more likely than not that the United States will have a smaller share of a Saudi market, which would result in a significant decline in the U.S. share of Middle Eastern exports.

Likewise, analysis of the Egyptian market leads to similar conclusions, although the United States is in a stronger position to influence events there through its economic assistance policy. A decline in the U.S. export share to Egypt, though, would have less of an effect on the overall U.S. export share, since Egypt is a smaller market.

An end to the Iran-Iraq War would probably increase the Middle Eastern market, but it is not clear that U.S. firms would necessarily benefit disproportionately from this trade opportunity. Dramatic political as well as economic changes would have to occur in order to expand U.S. export shares to the two countries—3 percent of exports to Iran and 7 percent of exports to Iraq from the six major industrial countries in 1982—sufficiently to soon bring them up to the 1982 regional figure of 22 percent. Furthermore, if U.S. exports remained a relatively small share of expanded Iranian and Iraqi markets, the U.S. regional market share would drop. In any case, it is difficult to anticipate events in these countries, and trade data are distorted by sales of U.S. products through third countries.[26]

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[26] Direct and indirect U.S. trade with Iran might have been two to three times higher than the direct trade recorded in 1982, if indirect transactions of U.S. products through agents or other intermediaries had been reflected as U.S. sales. Kenneth N. Gilpin, "Iran-U.S. Trade Up From 1980 Plunge," *New York Times*, Dec. 26, 1983, p. D1.

A sharp increase in unfair export competition from the other leading industrial countries might result in a decrease in the U.S. export share if U.S. policies were not changed to provide matching subsidies. Other important factors that could possibly reduce the U.S. share of exports to the Middle East are the fundamental ones that would affect the level of U.S. exports everywhere; for instance, low relative economic growth in the United States or disadvantageous shifts in comparative advantage that could result in perhaps lengthy adjustment periods.

Thus, there appears to be a set of plausible factors that could easily result in a significant decrease in the U.S. export share in the Middle East. These principally involve the potential for a fall in the U.S. position in Saudi Arabia and Egypt and the possibility of a continuing low U.S. share in post-war Iran and Iraq, which together could occupy a larger fraction of the region's imports. Other factors mentioned could also lead to a diminished U.S. share of exports. On a more optimistic note, only a decline in the value of the dollar holds clear promise for increasing the U.S. export share. OTA judges the low U.S. export scenario, therefore, to be more plausible overall than the high export scenario given the events underlying both.

CONCLUSION: PROSPECTS FOR THE 1990's

Because a significant decline in U.S. market share seems considerably more likely than an increase, and because maintenance of the current share depends primarily on maintenance of the U.S. export share with Saudi Arabia, where it may be difficult for U.S. exporters to maintain their 35 percent 1982 share of exports from the six top exporters, we come to the overall conclusion that the U.S. export share in the Middle East vis-à-vis the other major industrial countries will probably decline in the 1980's. A not completely, improbable low-share scenario could see the U.S. portion drop by half. Instead of securing 22 percent of the exports from the top six industrial countries exporting to the Middle East (18 percent of total industrial country exports) the U.S. share might very well drop significantly.

We also conclude that after a resurgence in 1984 and 1985, total industrial country exports to the Middle East will grow much more slowly in the 1985-2000 period than in the last decade because of very far-reaching changes in the oil economy. It seems plausible that over this 15-year period, exports to the Middle East will grow no faster than oil exports from the region. In the 1985-90 period this would mean a growth of imports of 2 to 5 percent per annum, if we use the range defined by our low and high revenue scenarios, followed by stagnating demand for imports in the 1990-2000 period.

There are important implications of this pessimistic trade outlook for the likely nature of future technology transfer to the Middle East and the role of U.S. firms and organizations in it. Technology transfers may increasingly take the form of the provision by Western firms of more specialized technical services in smaller contracts (more often with local joint venture firms). As a result of slowly growing revenues and because of past experience, Middle Eastern buyers may become more selective in their purchases of foreign technology, and local government intervention may help them to negotiate favorable terms. The emphasis that Middle Eastern countries have placed on diversification of suppliers, for political as well as economic reasons, can be expected to persist. To the extent that financing terms are also important considerations for buyers, mixed credits and other extraordinary supports for exports may be utilized more extensively by suppliers, despite the fact that the subsidy element has been greatly reduced in standard official export credits. These various trends suggest that technology transfers will involve more two-way interaction, in which suppliers are required to tailor transfers to the specific needs of Middle Eastern buyers.

While none of these trends identified above promises by itself to materially alter the volume of trade, they do point to changes in its nature and in the mechanisms for technology transfer. OTA's analysis in this chapter indicates that U.S. firms and organizations will probably not be able to substantially expand their positions in this changing Middle East market context, and that they will be challenged to maintain their shares. While there is no question that the United States will remain an important supplier country, the issue is whether the apparent comparative advantage that U.S. firms had in large-scale technical service exports during the past decade can be converted into a continuing advantage in smaller and more specialized exports of technical know-how, training and management that will contribute to a growth of indigenous technological capability in the region.

CHAPTER 15

Options for U.S. Policies Affecting Technology Transfer

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CHAPTER 15

Options for U.S. Policies Affecting Technology Transfer

The United States has no coherent policy governing civilian technology transfers to the Middle East, despite the fact that Congress has considered a number of proposals to establish one.[1] In the future, the Islamic Middle East will remain an important market for civilian technology trade, even if oil revenues grow more slowly than they did in the 1970's. The question is whether the United States can or should attempt more consistently to affect technology transfers to the region. The purpose of this chapter is to identify, in light of OTA's research, options available to policymakers in the next decade.

Although U.S. policies have not been systematically formulated to influence technology trade, many nevertheless do affect technology transfer. As analyzed in chapter 13, three major objectives of such policies have been commercial promotion, assisting countries in their development efforts, and limiting certain types of technology exports for military and political reasons. In recent years, these various objectives have all been pursued in an ad hoc fashion. The result has been an inconsistent set of policies affecting technology trade and transfer and an expansion of controls on exports. The dilemma for policymakers is that by pursuing one objective it becomes less possible to maximize others. Nevertheless, the absence of a strong consensus on priorities has resulted in this ad hoc approach.

Because U.S. technology trade with the Middle East has been strongly influenced by politics in recent years, it is unlikely that piecemeal changes taken with the goal of enhancing any one of the three major policy objectives would have strong effects on overall patterns of technology trade and transfer. Only a more consistent foreign policy perspective, which would drive policies affecting trade and transfer, would be likely to affect significantly the overall direction and nature of technology trade. This chapter outlines three policy perspectives that could be promoted in order to achieve the more ambitious goal of strongly affecting patterns of technology trade and transfer. These include: 1) selective use of technology to promote political interests; 2) decoupling technology trade from politics; and 3) promoting civilian technology transfer. OTA's analysis leads to the conclusion that it would be difficult to establish a consistent technology trade policy without a consensus on overall foreign policy goals.

POLICY TRADEOFFS

Congress has an interest in ensuring that economic assistance programs involving technology transfer are effective, that U.S. firms are free to compete on equal terms for sales in developing country markets, and that civilian technology transfers do not run counter to military and foreign policy goals. While each of these objectives has its virtues in the abstract, the dilemma has been that steps required to strengthen one require tradeoffs with others. In the discussion that follows, major tradeoffs are reviewed.

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[1] See, for example, House Committee on Science and Astronautics, Subcommittee on International Cooperation in Science and Space, *International Science and Technology Transfer Act of 1974*, hearings, May 21-23, 1974.

CONTROLS V. COMMERCE

During the past decade, controls on civilian technology exports have been expanded in order to achieve a variety of military and political goals. The institution of controls on exports of advanced civilian technologies generally implies a tradeoff with commercial interests. The essential debate is therefore between those who favor restricting exports for military or political reasons and those who point to the chilling effects on trade. The use of controls heightens the political dimension of technology trade, particularly when individual nations are singled out for special treatment in the absence of an international crisis that would obviously justify such measures.

Controls of all types are susceptible to criticism on two grounds: disproportionate commercial sacrifice and ineffectiveness in achieving political goals. On the other hand, proponents of controls view the effort to achieve national security and foreign policy aims as worth the commercial sacrifice. In some instances, where it would be inappropriate for the United States to use military force to achieve political objectives, proponents of controls argue that trade is a valuable lever, and sometimes the only arena in which action can safely be taken. In their view, even if controls are not completely effective in achieving desired results, they make the position of the United States clear. On the other hand, opponents of controls point to what they see as the limited effect that restrictive U.S. export policies may exert in the absence of coordination with other Western supplier governments. Because a number of suppliers can generally provide comparable advanced civilian technologies, the United States is not in a position unilaterally to control access. OTA's research indicates that West European nations and Japan are not willing to institute controls on civilian technology trade with the region.[2] However, proponents of controls would argue that the United States should not allow other nations, even allies, to dictate its policies.

As discussed in chapter 13, U.S. policymakers have introduced controls of various types affecting technology transfer to the Middle East. Some of these controls apply only to trade with Middle Eastern countries, while others apply more generally to exports worldwide. The United States has used controls on trade more often than any other nation, and these controls have been deployed more frequently with each passing decade.[3] The expansion of controls on trade with various Middle Eastern nations has been particularly noticeable in recent years.

National Security Controls

National security controls, which restrict militarily significant exports to Soviet bloc nations, affect Middle East nations (except Libya[4]) as they do all nations not included in the Soviet bloc. Few question the need for national security controls or those covering military exports, but debates continue concerning the definition of "military significance" and concerning the treatment of non-Communist nations.

Congress has considered a number of proposals to extend controls governing dual-use items (i.e., products with both military and civilian uses) such as large-scale computers, certain kinds of materials testing equipment, and items used for the production of special nuclear materials. These high-technology, dual-use items are currently included on the Commodity Control List (which incorporates the Nuclear Referral List), and official approval is required for export. While controlling the export of items that have a direct or sole military use poses no serious controversy, there is much disagreement about inclusion of dual-use items. Experts disagree about how important such dual-use items are to military development and whether denial will seriously disadvantage the Soviet Union. One proposal under consideration in Congress would prohibit the sale of dual-use items to any nation not a signatory to the Nonproliferation Treaty (NPT). Only a small percentage of dual-use license applications (about 6 percent) have been granted for exports to Islamic countries in the Middle East.[5] It is unlikely that institution of such restrictions on dual-use items would result in denial of access to recipients, since in most instances other supplier nations are in a position to sell them, but the institution of such controls could be expected to reduce U.S. exports to some Middle Eastern countries.

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[2] Japanese and West European perspectives on export controls on trade with the Soviet bloc are analyzed in *Technology and East-West Trade* (Washington, D.C.: U.S. Congress, Office of Technology Assessment, OTA-ISC-101, November 1979) and *Technology and East-West Trade: An Update* (Washington, D.C.: U.S. Congress, Office of Technology Assessment, OTA-ISC-209, May 1983).

[3] Gary Clyde Hufbauer and Jeffrey Schott, *Economic Sanctions in Support of Foreign Policy Goals* (Washington, D.C.: Institute for International Economics, 1983), p. 8.

[4] Effective Mar. 12, 1982, controls were expanded on trade with Libya beyond those included under antiterrorist controls. Libya was placed in Commodity Group S. See U.S. Department of Commerce, International Trade Adminstration, *Export Administration Annual Report FY 1982* (Washington, D.C.: U.S. Government Printing Office, 1983), p. 31.

Some wish to extend national security controls to non-Communist nations because U.S. technology can flow through third countries to the Soviet Union. Proposals to strengthen the controls on transfer of many items to all nations worldwide acknowledge the potential threat to the United States of technology diffusion through third countries. However, such proposals would require a considerable expansion of government efforts, and the burden of more stringent controls on licensing would fall heavily on multinational corporations. It should be noted, however, that there is strong support for the national security controls currently operating. For example, there has been little debate about whether they are appropriate in discussions of renewal of the Export Administration Act; disagreement has arisen primarily about how such controls could be perfected or extended.

Nonproliferation Controls

With respect to nonproliferation controls, the United States is not a major supplier of nuclear equipment to Islamic countries in the Middle East. Proposals to extend controls to dual-use items, as discussed above, could specifically affect dual-use exports to those nations not signatories to the NPT, such as Algeria, Israel, and Saudi Arabia. In addition, decisions concerning supply of spare parts and nuclear technologies to nations, such as India, (which in the years ahead may become new suppliers to Middle East countries) may also be relevant over the long term. Debates continue between those who argue that the United States must carry on a dialog with such nations (and supply nonsensitive equipment to them) and opponents who question the wisdom of providing any type of assistance to nations that have not accepted full-scope safeguards and may become new suppliers of nuclear technology in the years ahead.

Chapter 9 identified specific measures that could strengthen incentives for reducing the spread of nuclear weapons in the Middle East. Most of these measures would depend on cooperation with other supplier nations. These include agreements among suppliers to limit exports of highly enriched uranium and laboratory-scale sensitive facilities, and strengthening of safeguards, including measures such as improved remote-sensing monitoring devices.

In addition, the United States could unilaterally adopt some measures that could affect nuclear weapons proliferation in the region. The major controversy is between those who oppose any type of nuclear cooperation with nations in the region, and those who argue that the United States can best influence recipient countries by assisting them in peaceful nuclear programs. Those in the first group favor hindering by any means available the growth of nuclear knowledge and infrastructure, even when the relationship to a weapons program is indirect or remote. They therefore support the use of strong measures, including prohibitions against Export-Import Bank financing of nuclear exports, restrictions on foreign students studying in the United States, and withdrawal of support for organizations such as the International Atomic Energy Agency over issues of political principle, such as the refusal to accept Israel's credentials. In contrast, those who favor providing assistance see it as a powerful way to achieve nonproliferation goals. The bilateral nuclear cooperation treaty with Egypt is, in their view, a major accomplishment in that strict nonproliferation provisions are included in exchange for assistance from the United States.

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[5] Among the nations in the region, the largest percentages of licenses for export of dual-use items in recent years have been granted for exports to Israel, a nation not a signatory to the NPT. Saudi Arabia, also a nonsignatory, has made significant purchases, as well. See General Accounting Office, *Controlling Exports of Dual-Use, Nuclear-Related Equipment*, Sept. 29, 1983, p. 8.

OTA's research suggests the merit of an approach based on the assumption that the United States must deal realistically with the fact that many developing nations see commercial nuclear power as an important part of their development plans. Both proponents and opponents of expanded restrictions on nuclear exports would view increased efforts to assist developing countries in alternative energy development, including solar energy, as acceptable. Rigid policies relying exclusively on denial of all nuclear technologies can be expected to reduce U.S. influence on the nuclear programs of Middle Eastern nations.

Foreign Policy Controls

In contrast to the situation with respect to existing nonproliferation and national security controls, where there is general support for the controls themselves and where disagreements focus on where to draw the line between military and civilian items, there is considerable disagreement as to whether foreign policy controls are at all effective. These types of controls have been used to restrict exports of aircraft of various types to nations supporting terrorist activities, including Syria, Libya, the People's Democratic Republic of Yemen, Iran, and Iraq.[6] In addition, controls on trade with Iran were used during the hostage crisis. Unlike the other types of controls discussed above, foreign policy controls have been applied selectively to Islamic countries in the Middle East.

Proponents of these controls view them as, at a minimum, important for their symbolic value in clarifying the opposition of the United States to regimes supporting terrorist activities. However, the actual effect of these controls in injuring or pressuring the target is often limited because other supplier nations can step into the breach and because the target countries are, in most cases, not friendly with the United States and may therefore prefer to trade with other nations. Foreign policy controls can be effective when other OECD nations also restrict exports or support U.S. policies in other ways. Some observers believe that this was the case with foreign policy controls instituted against Iran during the hostage crisis.[7] Opinions differ about the effects of controls used against Libya.

Because the President has considerable discretion in instituting these controls, controversy inevitably surrounds their usage. In no case has the application of such controls alone led to the clear achievement of objectives such as termination of terrorist activities. While the precise effects cannot be measured, such controls certainly put a chill on U.S. trade relations with the targeted countries and may increase doubts about the reliability of the United States as a supplier. Given the availability of aircraft from other suppliers and the other problems mentioned above, it appears unlikely that foreign policy controls can be expected to restrict access severely to advanced civilian equipment, and it is doubtful that such controls will substantially modify the behavior of nations to which the sanctions are applied. Nevertheless, these controls do limit involvement by U.S. firms in certain nations, and they have been viewed as one of the few available ways that the United States can publicly impose sanctions on nations for supporting terrorism.

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[6] Foreign policy controls against Iraq are no longer in effect. On Jan. 23, 1984, Iran was added to the list of nations included under the antiterrorism controls. See "Determination Pursuant to Section 6(i) of the Export Administration Act of 1979—Iran," *Federal Register*, vol. 49, No. 15, Jan. 23, 1983, p. 2836.

[7] A recent analysis by Hufbauer and Schott, cited earlier, concluded that the sanctions imposed against Iran during the hostage crisis were comparatively successful, while the result was doubtful in the case of sanctions used against Libya.

Antiboycott and Other Policies Regulating U.S. Business Overseas

As with foreign policy controls, it is impossible to assess the precise trade effects of other types of regulations affecting U.S. business operations in the Middle East, such as antiboycott regulations and the Foreign Corrupt Practices Act. Both of these policies have been strongly criticized by the business community as unique U.S. policies that disadvantage U.S. firms vis-a-vis their competitors. Because it has been implemented solely in the Arab boycott of Israel, the antiboycott policy has been opposed by businessmen and others who see it as reducing U.S. commercial interactions with Islamic countries. In addition, opponents criticize U.S. opposition to the boycott as inconsistent with U.S. export controls that aim to use trade as a lever. The proponents, in contrast, say that antiboycott policies preserve U.S. commitment to the principle that controls should not be extended to third parties. They also maintain that the actual commercial losses from the boycott are minimal, noting that Arab nations often waive boycott regulations when they have special need for a particular kind of equipment or technology.

OTA's research suggests that efforts to extend controls can best be focused on improving nuclear nonproliferation controls and those covering military exports. Expanding other types of controls, such as foreign policy controls which apply solely to Middle East countries (either to cover more nations or to include additional items), would certainly heighten the political dimension of technology trade, and it is not clear that they would prove effective in meeting goals such as reducing terrorism. Placing primary emphasis on nonproliferation and national security controls could increase the predictability and maximize the effectiveness of controls. Only under unusual circumstances, such as the Iranian hostage crisis, when the positions of other Western supplier nations were strongly unified and supportive, has there been evidence that controls on civilian trade have contributed to achievement of the desired foreign policy goal. Even in that case, however, other types of measures were employed, and the exact contribution of foreign policy controls is not clear.[8]

THE ROLE OF TECHNOLOGY TRANSFER IN FOREIGN AID

Two Middle East nations, Egypt and Israel, are the largest recipients of U.S. economic assistance of any nations worldwide. The importance of U.S. Government-supported assistance programs, including those designed to promote technology transfer, will probably increase if economic growth proceeds at a slower pace than was the case in the the 1970's in the Middle East. Not only the lower-income nations, but the middle- and higher-income Middle East nations as well, seek to promote technology absorption in order to build indigenous capabilities. At the most general level, the major points of disagreement concerning development assistance pertain to allocation of scarce resources and the potential for political backlash.

Economic Assistance and Political Influence

There is no agreement concerning the relationship between economic assistance and U.S. political influence. Some worry that U.S. assistance programs may not always win friends, but may lead to resentment by recipients. On the other hand, many others argue that economic assistance is a critical element of U.S. foreign policy in the Middle East. More specifically, the express desire of many Middle Eastern nations to acquire Western technology indicates that economic assistance involving technology transfer can be a particularly important aspect of U.S. foreign policies.

OTA's research confirms that effective development assistance programs can assist the United States in winning friends and countering Soviet bloc presence. At the same time, however, it is important to temper expectations of political gain with a recognition that political backlash can also result. Recipients sometimes resent the advice given by foreign aid officials whose job it is to see that funds are spent effectively. In addition, if programs grow rapidly, recipients may find themselves facing economic problems associated with heavy reliance on foreign subsidies. Despite these problems, because nations of the region generally view Western technology as superior to that of the Soviet bloc, technology transfers from the United States are clearly important elements in the development strategies of these countries.

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[8] Other policy instruments, such as quasi-military actions taken in an attempt to rescue the hostages, were used in conjunction with the trade sanctions.

Technology Transfer v. Other Goals of Economic Assistance

A case can be made that development assistance programs emphasizing technology transfer contribute more effectively than other types of economic assistance to the long-term economic well-being of the recipient nations. In contrast to simply giving away food or commodities, programs involving technology transfer may have longer term effects because they assist recipients in developing their own capabilities. Such programs have the potential for fostering the development of lasting human relationships between individuals in recipient and supplier countries.

On the other hand, programs involving technology transfer require the expenditure of considerable resources—financial and organizational. It is too much to expect that **all** aid programs be directed at promoting technology transfer in a country like Egypt, where aid officials are pressed to expend the funds allotted. If the goal is to promote more extensive technology absorption, doubling the aid budget alone would not necessarily achieve desired results. Small-scale, focused programs, moreover, may contribute significantly to technology transfer in key sectors. While some argue that recipient countries should be given more flexibility in the use of aid funds, programs involving technology transfer require extensive coordination between individuals from recipient and supplier countries. Continuing involvement by the donor is a prerequisite for such programs, but such involvement in the host country may lead to the types of resentment mentioned above when programs grow so rapidly that they cannot be effectively managed.

ECONOMIC ASSISTANCE AND COMMERCIAL PROMOTION

Economic assistance programs clearly provide export opportunities for firms of supplier countries. Other supplier countries, such as Japan and West European countries, acknowledge and attempt to capitalize on this linkage more than the United States has. Nevertheless, in practice, U.S. economic assistance has also provided export opportunities involving equipment and technical services for U.S. firms. Indeed, procurement regulations ensure that U.S. firms are the major suppliers, sometimes despite the fact that other suppliers can provide lower cost goods.

At the crux of disagreements is the fear on the part of some that aid goals would be distorted by a more conscious linkage of aid to commercial promotion. U.S. assistance policies have, in recent years, emphasized helping the poorest nations meet basic human needs, aims which are primarily humanitarian. Those who support this general thrust worry that more extensive involvement of U.S. business, in programs such as private sector initiatives, may skew assistance to those projects most in the interest of U.S. business, and not necessarily to those most likely to benefit the average citizen in the Middle East. On the other hand, many note that in practice, particularly in procurement regulations, U.S. aid benefits U.S. business. Since many other suppliers are willing to combine aid with commerce in mixed credits and other areas, such as bilateral technical assistance agreements, they say that the United States ought to do likewise. OTA's research indicates that more explicit recognition of the links between commerce and assistance could at least contribute to a better understanding of the interrelationship. Because the technology transfers most important for the user industrial and service firms are normally provided by private sector U.S. firms, policies designed to enhance the participation of U.S. private sector (including nonprofit) organizations could be particularly important.

A related area of dispute concerns the question of whether U.S. aid should be directed solely to the poorest countries, or whether middle- and even upper-income developing countries are appropriate recipients. In recent years, the view that assistance should be concentrated in those nations in greatest need has been prominent. Some, who view philanthropic goals as primary, question the appropriateness of aid to richer countries as incorrect not only in view of budgetary constraints, but also on the grounds that commercial interests may take precedence. Others observe that, particularly in the Middle East, many nations enjoying comparatively high levels of gross national product per capita nevertheless need technical assistance to expand their productive manufacturing facilities. Such assistance can be and is, of course, purchased from private U.S. firms. Other West European supplier governments have in some cases promoted technical assistance programs in the oil-rich as well as the lower-income nations of the region.

OTA's research suggests the merit of programs promoting technology transfers in industry and services in addition to those that already exist in areas such as health care and agriculture. Programs focusing on the needs of the end-users of technology in manufacturing and service systems are especially critical. In particular, assistance in technology selection and the setting of performance standards, specialized technical manpower training programs, programs designed to improve maintenance and servicing of facilities, and efforts designed to adapt technology to local requirements are needed in countries throughout the region. Those programs responding to the concrete needs of the organizations and firms that carry out the production processes stand the best chance of providing tangible gains and of leading to self-sustaining activities. Such efforts are essential for all middle- and upper-income Middle Eastern countries, as well as for those not rich in oil.

THE COSTS AND BENEFITS OF COMMERCIAL PROMOTION POLICIES

The benefits of commercial promotion policies are primarily economic and accrue most directly to the exporting firms, while the costs are sometimes calculated in political as well as economic terms. The major disadvantages of commercial promotional policies are that in some cases they may run counter to foreign policy goals, and they involve costs to the U.S. taxpayer. Those who oppose policies promoting technology trade with Middle Eastern countries may do so for a number of reasons. Depending on the type of export involved, they may judge that acquisition could contribute to the military power of an adversary or potential adversary. In addition, some worry that the involvement of U.S. firms overseas may lead to movement of production offshore so as to disadvantage U.S. labor. Others wish to reduce U.S. interactions with nations whose foreign policy positions do not conform to their definition of U.S. interests. In addition, some have also opposed promotional policies on the grounds that the U.S. taxpayer should not be asked to bear the costs of programs seen as benefiting only a few firms.

Generally, supporters of promotional policies see commercial interactions as the foundation for peaceful relations between countries. They see the expansion of U.S. export controls during the past decade as setting a uniquely negative context for technology trade, which may lend U.S. firms a reputation as unreliable suppliers. Supporters of promotional policies note the more extensive policies of other supplier countries and argue that the U.S. Government should do more to support U.S. exports so that U.S. firms can remain competitive. In their view, the movement of production offshore cannot be stopped, since it occurs in conjunction with technological change and shifts in comparative advantage. Finally, proponents see Government support for exports as beneficial not only to the specific exporting firms, but also to the U.S. economy more generally. In their view, the United States can only maintain a technological lead by continuing to innovate and compete successfully in world markets through both sales of products and technology.

As discussed in detail in chapter 13, it is not always easy to identify U.S. economic interests, nor is it possible to equate them with the interest of particular firms. Large U.S. firms have been prominent as project managers and providers of technical services. While many smaller firms are involved as subcontractors and their exports improve the overall national balance of payments, large firms generally have been most willing and able to take on the risk incurred when a firm commits itself to the ongoing process of technology transfer in a developing country. In addition, large Middle Eastern projects are normally multinational, involving U.S. firms along with those from many nations. This trend of growing tie-ins with foreign competitors is apparent in many research-intensive industries worldwide and certainly not unique to business operations in the Middle East. The real question, however, is when and how the U.S. Government should promote commercial technology trade and transfer. This dilemma is particularly apparent when two or more U.S. firms compete for contract awards because commercial officers are expected to maintain neutrality in their representation efforts.

Debates over export subsidies illustrate disagreement concerning not only who benefits and who loses from promotional policies, but also tradeoffs between short-term gains arising from mercantilist policies versus long-term benefits of a free trading system. OTA's research confirms the widely held view that many Western supplier countries have developed more extensive commercial promotion policies than those of the United States. Because the United States has been historically committed to pursuit of an open international trading system, many are reluctant to adopt an approach that would require emulation of the extensive subsidies offered by foreign supplier governments. On the other hand, a growing number of observers have suggested a variety of measures that would provide the U.S. Government with expanded capability to offer export credits. In their view, the U.S. Government should not stand by while other supplier nations provide more extensive supports for their firms.

Debates concerning subsidies are sometimes carried out in extreme terms: whether to emulate foreign supplier programs or to withdraw. Put in other terms, there is a perceived tradeoff between the goals of expanding U.S. exports and the adverse consequences on all countries of increasing protectionism. Despite the apparent tension between these goals, a number of less dramatic measures could be employed without jeopardizing multilaterally agreed-upon trade rules. The lending authority of the Export-Import Bank could be expanded to match foreign subsidies within the limits internationally agreed on by the OECD and the GATT (General Agreement on Tariffs and Trade). Similarly, the United States could continue to work to expand international agreements covering domestic subsidies and trade in services and to identify cases of unfair subsidies offered abroad in order to call them to international attention.

OTA's research indicates that improvements in routine business representation overseas, coupled with measures to improve the capability of the U.S. Government to collect and analyze information about foreign trade and investment, are additional concrete steps that would assist exporters. Thus, there are a number of alternatives open to policymakers short of emulation of the more aggressive financing policies of other supplier nations. OTA's work suggests that such moderate measures that do not constitute aggressive mercantilism would be significant in supporting U.S. business overseas. They are, however, unlikely to change the competitive positions of U.S. firms in Middle Eastern markets quickly or dramatically.

THE PROMOTION OF TECHNOLOGY TRANSFER THROUGH COMMERCIAL POLICIES

Few commercial policies have been designed with the express purpose of promoting technology transfers. One reason is the concern that technology transfers promote the development overseas of industries that will compete with U.S. firms and lead to loss of jobs in the United States. In contrast to export promotion, programs supporting technology transfer imply a longer term involvement of U.S. firms. Some see this involvement primarily as commercially beneficial, while others worry about investment risk.

The one U.S. agency which assists potential investors by providing insurance and other services is the Overseas Private Investment Corporation (OPIC). OPIC in its reviews of applications for insurance considers the extent to which commercial investments in developing nations will result in technology transfers. Congress has also required OPIC to take into account the employment and trade effects on the United States of potential projects. OPIC-supported projects reflect consideration of a variety of U.S. policy goals. U.S. investors are rightly cautious about investing in foreign nations; OPIC insurance guarantees could be enlarged if policymakers decided to promote technology transfers. In that situation, a number of other options could be considered. For example, firms exporting technical services could be assisted in other ways: U.S. economic assistance funding could be provided to support the technical training component of certain projects viewed as particularly worthy, or special tax treatment could be provided to firms exporting technical services required for technology transfer to developing countries. In addition, bilateral trade and investment treaties could be considered.

Photo credit: U.S. Overseas Private Investment Corp.

U.S. engineers worked with Saudi project managers in planning and scheduling construction at King Faisal Hospital in Saudi Arabia. The project was supported by OPIC

OTA's research showed that, among the technology transfer sectors examined, only technology transfer in petrochemicals will contribute to the growth of a Middle Eastern export industry. By far, the great majority of technology transfers to date stimulate the growth of industries and services producing for local Middle Eastern markets. Over the long term, however, Middle Eastern countries will produce more goods and services for export, and technology transfers will contribute to the growth of this export capability.

In the last analysis, however, decisions taken by U.S. firms themselves more importantly influence their export success than do Government policies. Nevertheless, commercial promotional policies can provide a supportive climate for exports and technology transfers.

POLICY PERSPECTIVES

Considering the tradeoffs discussed above, it is not surprising that a coherent technology transfer policy has not been established. In particular, the tension between political and economic interests has been a pervasive theme. Actions have been taken simultaneously to achieve differing policy goals. New measures could be introduced to further any one of

Photo credit: Saudi Arabian Ministry of Commerce

Desert scene

three general goals (commercial promotion, development assistance, safeguarding U.S. security), but it is unlikely that such measures would alter dramatically the volume or nature of U.S. technology trade with the region. Without an overarching consensus reconciling political and economic interests, the effects would remain inconsistent.

Policymakers may wish to alter substantially the scope and nature of commercial technology transfers to the Middle East by developing a more consistent perspective on technology trade and transfer to the region. In order to do so, a new understanding of the role of technology transfer in U.S. foreign policy would have to be established and widely accepted. Three general perspectives are outlined below. In each case, specific policy measures of various types (development assistance, export controls, and commercial promotion) could be selected.

PERSPECTIVE 1: SELECTIVE USE OF TECHNOLOGY TO PROMOTE POLITICAL INTERESTS

The crux of this strategy is to provide friends and deny enemies access to U.S. technology. This policy perspective would make technology trade the servant of U.S. foreign policy toward the Middle East. The U.S. Government would extend and use controls selectively to impose sanctions on nations whose policies run counter to those of the United States. All of the controls mentioned earlier could be used to deny access to U.S. technology to unfriendly nations, but technology could be used systematically as an incentive as well as a deterrent.

As a complement to the policy of denial, the Government could reward certain nations by providing them with advanced technologies. Exceptions to overall export policies could be used to single out friendly nations for special treatment. Sales of dual-use technologies, in particular, would be promoted officially by the Government. Development assistance programs could be a major vehicle for providing rewards, with programs involving technology transfer receiving special emphasis. Commercial promotional programs involving U.S. businesses would be strongly tied to foreign policy goals. Thus, whether used as stick or carrot, civilian technology would be employed for furthering U.S. foreign policy goals.

This option has the advantage of placing major emphasis on U.S. foreign policy interests that are of central importance to policymakers. The attraction of this policy option is that it capitalizes on technology as a potentially effective instrument for influencing the behavior of key actors in the region. Furthermore, in cases where other policy measures are unavailable or inappropriate, this option would allow for systematic use of denial. On a more positive note, the provision of advanced technologies to nations closely associated with U.S. foreign policy positions could significantly enhance their regional and global stature.

Such a policy option has some drawbacks, however. The success of this option depends on accurate forecasts of foreign policy orientations of Middle Eastern countries. Because political alignments shift with regime changes and developments in the region, one danger would be sudden interruptions of technology transfers due to political shifts, probably requiring U.S. Government compensation to firms involved. This approach would place considerable burdens on the U.S. Government to oversee commercial technology trade and might result in buyers simply turning to other suppliers. OTA's analysis of impacts of technology transfers indicates the severe difficulties in anticipating in advance the effects, particularly political and social effects, of technology transfers. This policy option could also be impeded by disagreement within the Government or the larger society about the appropriate U.S. policies toward specific nations. It would certainly politicize even more strongly U.S. technology trade and would run the risk of jeopardizing relations with nations not closely associated with U.S. positions, yet not closely allied with unfriendly countries.

PERSPECTIVE 2: DECOUPLE COMMERCIAL TECHNOLOGY TRADE FROM POLITICAL INTERESTS

Policymakers may wish to reduce the linkage between politics and economics which has distinguished policies of the United States from those of other supplier nations. This option is based on the assumption that technology trade with all nations, regardless of their political relations with the United States, should be vigorously promoted. U.S. political and diplomatic strategies could proceed independently, while trade in nonmilitary items would be permitted with any nation in the region where U.S. firms judged the market opportunity worth the risk of investment or involvement. This would require elimination of controls for nonmilitary exports designed specifically to influence exports to the region (foreign policy controls and the antiboycott program). Under such an approach, U.S. policies would more closely resemble those of other suppliers, specifically Japan and Western European countries.

The advantage of such a policy option would be to expand commercial opportunities and to eliminate the tension that has existed between commercial and military/political issues. A major attraction of this perspective is that it would put U.S. firms on a more equal footing with their Japanese and West European competitors, and possibly lead to the expansion of U.S. exports to Middle Eastern countries that are not currently major trading partners. In addition, it would place fewer demands on Government officials to oversee technology trade and provide opportunities for establishing a presence in nations not currently allied with the United States.

Such a policy option would limit the policy instruments available to the U.S. Government, however, because the presumption would be that technology trade would not be used as a lever. In addition, because U.S. firms would be expected to increase exports to nations not closely associated with U.S. policy positions, the probability would increase that the U.S. Government might be required to protect American citizens abroad or assist firms exposed by political changes.

On the other hand, such a policy would probably not be adequate to quickly or completely eliminate the selective pattern of technology trade. OTA's research indicates that technology trade has in the past been strongly influenced by U.S. foreign policies: even if the disincentives for nonselective trade were terminated and more vigorous promotional policies were put in place, U.S. firms would probably still continue to prefer sales to friendly nations where the risks of investment are perceived to be lower than in other countries. Conversely, sales would be difficult in countries where there is strong hostility to the United States. Furthermore, assuming that economic assistance policies remained strongly tied to larger foreign policies, incentives for selective technology trade would remain. In order to expand trade, this approach could be widened to include vigorous promotional policies. On the other hand, simply eliminating some political controls on trade would undoubtedly encourage wider trading relationships over time.

PERSPECTIVE 3: PROMOTE CIVILIAN TECHNOLOGY TRANSFER

Neither the technology leverage nor the decoupling perspectives are specifically oriented toward policies affecting technology transfer. In both cases, the effects on technology trade, particularly exports of products, would be more noticeable than effects on technology transfer per se. Policymakers may wish to facilitate expanded technology transfers from the United States, and more extensive technology absorption by recipients, through establishing a clear and explicit policy. This approach is based on the assumption that civilian technology transfers have been generally mutually beneficial and that the Government should do more to encourage them. Many observers see this as a "natural" policy, since the United States excels in technology development, and technology absorption is a key component of economic development. Underlying this perspective is a conviction that it is misguided to try to control access to U.S. civilian technology and a recognition that the United States can best maintain its strength in technology development by participating actively in international technology exchange. This approach could include the retention of national security and nonproliferation controls, and it could leave open the option of employing trade controls under extraordinary circumstances, such as the Iranian hostage crisis. However, the major thrust would be to facilitate expanded transfers of civilian technologies. Product and equipment exports could be expected to increase somewhat, but technology transfer would be the centerpiece.

As indicated earlier, policy measures designed to foster commerce and development assistance could be used to promote technology transfer. These might include increasing the numbers of development assistance programs aimed to transfer technology in manufacturing and service industries; providing incentives to private sector organizations (including nonprofit organizations) to participate in such projects; expanding technical assistance to middle- and upper-income nations; increasing Government financing and insuring of projects involving technology transfer (through programs of the Overseas Private Investment Corporation and the Export-Import Bank); upgrading the technical capabilities of commercial and aid representatives overseas; and expanding bilateral technical assistance agreements in specialized fields.

OTA's research indicates that the Federal Government has only very limited capabilities to assess trends in international technology transfer. A significant step forward would be to improve data collection for trade in technical services. In addition, the Federal Government could play a stronger role, in cooperation with private sector groups, in improving the flow of information between recipients in developing countries and U.S. firms and organizations.

Given the varied human, capital, and natural resources of Middle Eastern countries, technology transfer has important regional significance. The training of technical personnel in one Middle Eastern country, for example, may benefit other countries—through the migration of labor or through the training of foreign nationals. Some types of Government-supported training programs and technical assistance efforts could include representatives from a number of recipient (and perhaps supplier) countries. In addition, programs could be carried out in conjunction with regional organizations. The education of Middle Eastern students in technical and scientific fields in the United States is an important channel for technology development and transfer. Programs directed toward professional enrichment and retraining at midcareer could also be introduced. Finally, international agreements promoting fairness in service trade, in use of mixed credits or adjustments to the anticipated growth of Middle Eastern exports, could be pursued.

This approach implies considerable resource allocation by the Government to new and expanded programs, and some coordination of the efforts of various agencies. One problem would inevitably be to introduce overall consistency or direction in these varied programs. Another type of challenge would be in designing programs that effectively promote technology transfer and in evaluating their success. In addition, because technology transfers involve longer term interactions with recipients than required for exports, and because the approach involves a balancing of political and economic interests, serious disagreements could arise about when "extraordinary circumstances" justify use of trade controls. Furthermore, regional conflict or local political instability present obstacles to the implementation of perspective 3 to an even greater extent than would be the case for perspective 2.

The approach could capitalize on technology transfer as an important commercial and political asset, possibly opening relations with nonaligned countries. Assuming that a consensus in favor of civilian technology transfer to developing nations were established, such programs could enhance the influence and prestige of the United States in the Middle East and contribute to regionwide development.

CONCLUSION

Each of the three policy perspectives outlined above centers around a consistent strategy emphasizing political and economic interests to different degrees and in different ways. Because of the persisting tradeoffs between objectives (particularly the tension between political and economic interests), there are formidable obstacles to the formulation of a comprehensive policy and a consistent strategy. Although each perspective may have its virtues in the abstract, a new consensus on overall foreign policy direction would be necessary to implement any one of them fully.

Even if no consistent policy were established, U.S. policymakers will continue to face a fundamental choice as they deal with these issues on a case-by-case basis: they can encourage or discourage commercial technology transfers through the choices they make. OTA's research indicates that commercial technology transfers to the Islamic Middle East have been generally beneficial economically and that all the nations in the region place high priority on technology trade and transfer in their development planning. Therefore, U.S. policies—regardless of which goals are maximized—will remain important to nations in the region.

In the decade ahead, the Middle East will remain an important market for equipment and technical services as well as a region of great strategic importance to the United States. Instead of subordinating politics to economics, the challenge is to balance these interests in a more consistent way. The question is whether U.S. policies can be designed to enhance the mutually beneficial aspects of commercial technology transfer without jeopardizing political interests. Without a more consistent policy, the pattern of expanding controls and selective technology trade characteristic of years past will probably persist.

OTA's research indicates, at a minimum, the need to consider the implications of other policies on patterns of technology transfer. More generally, technology transfer from the United States to the Middle East can be viewed as a major component of U.S. influence in the region. Although unanticipated negative effects have occurred, civilian technology transfers have in practice supported mutually beneficial relations with countries of great strategic and economic importance to the West.

Appendixes

Appendix A

Selected Medical Services Projects in the Middle East

Table A-1.—Medical Services Contracts in Saudi Arabia

Project	Awarded to	Ownership	Public or private	Supplier nation	Location	Year of initiation	Production level
1) Hospital staffing and management	Whittaker Saudi Arabia, Ltd.	70% U.S. Corp. 30% HRH Khalid Bin Abdullah Bin Abdulrahman Al-Saud	Ministry of Defense and Aviation (MODA) contract w/joint venture U.S. Corp. and private Saudi partner	United States	Jeddah, Khami's Muchayt, Tabuk	1981	To staff and operate 3 hospitals
Size of personnel: 2,000 to begin, later to double *Dollar value:* $334 million *Major Saudi participants:* MODA, private partner							
2) Hospital area 15H	Kuk Dong Construction Co., Ltd./Al Mashrik Contracting Company	Korean and Saudi joint venture	MODA contract with Korea private joint venture companies	Korea	King Khalid Military City, Al Batin	1981; completion date mid-1985	To build a 300-bed hospital
Size of personnel: unknown *Dollar value:* $164.8 million *Major Saudi Participants:* Al Mashrik Contracting Company							
3) Four 100-bed hospitals	Dragages et Travaux Publics/El Seif Engineering and Contracting joint venture	France and Saudi Arabia	Ministry of Health (MOH) contract with private joint venture	France	Ula, Qunfuda, Rabigh, Adum	1981	To build, equip, furnish four 100-bed hospitals
Size of personnel: unknown *Dollar value:* $199.6 million *Major Saudi participants:* El Seif Engineering and Contracting *NOTES:* Subcontractor: AEG of Germany for electrical work							
4) Hospital management	International Hospital Group (IHG) [Major competition came from Belgium, France and U.S.]	United Kingdom	Saudi Arabian National Guard contract with private firm	United Kingdom	Jeddah	1981	To commission and operate the 500-bed National Guard hospital in Jeddah constructed by Eurosystem Hospitalier of Belgium
Size of personnel: approximately 1,500 *Dollar value:* $272.8 million *Major Saudi participants:* — *NOTES:* Subcontractors include: International Aeradio, Grand Metropolitan; the Wellcome Foundation; PA Management Consultants; Peat, Marwick, Mitchell and Co.; International Laboratory Services; Cusdin, Burden and Hewitt; Donald Smith; Seymour and Rooley; and Hanscomb International for services ranging from accountancy to architecture to specialized consultancy work.							
5) Hospital management	Hospital Corporation of America (HCA)	United States	National Guard contract with private firm on a government-to-government basis	United States	Riyadh	1982	To staff and manage the 500-bed hospital for 30 months.
Size of personnel: 1,500 by end of contract *Dollar value:* $350 million *Major Saudi participants:* National Guard							

Table A-1.—Medical Services Contracts in Saudi Arabia (continued)

Project	Awarded to	Ownership	Public or private	Supplier nation	Location	Year of initiation	Production level
6) Two 100-bed hospitals	Laing Wimpey Alireza	Laing Wimpey Alireza, a U.K./Saudi joint venture	MOH contract with private companies	United Kingdom, Italy, Canada	Bakeriyya and Mizheb	1981	To construct two 100-bed hospitals each with maternity wards, gynecology, physiotherapy, pediatrics, radiotherapy, dentistry, two operating theaters, blood bank and hemctology lab.
Size of personnel: Unknown *Dollar value:* $90.9 million *Major Saudi participants.* Alireza *NOTES:* Subcontractors include: John Laing Design Associates, Totaltermica, Redi Electric, Arabian Consultant Engineering Center, Canadian Health Care.							
7) Hospital	El Seif Engineering and Contracting/ Dragages et Travaux Publics/Samsun Construction Company	Saudi, French, Korean	MOH contract with private companies	France, Korea,	Qatif	1981	Construction of a 345-bed hospital with screening clinic, ancillary buildings, housing, and all medical equipment
Size of personnel: Unknown *Dollar value:* $102.3 million *Major Saudi participants:* El Seif							
8) Public Security Hospital-Phase II	Ballast Nedam Group and Gustav Epple (design by Llewelyn-Davies Weeks)	Netherlands and West Germany (U.K.)	Ministry of Interior contract with private firms	Netherlands, West Germany (U.K.)	Riyadh	1981	To expand existing 105-bed PSH to add 179 beds and establish 8 intensive care units, 4 units for heart patients, 7 operating theaters, and outpatient facilities
Size of personnel: Unknown *Dollar value:* $166.7 million *Major Saudi participants:* —							
9) Health services	Charter Medical Saudi Co., Ltd.	Joint venture between Saudi Medical Services (90%) and Charter Medical Corp. (10%)	MODA contract with private companies	United States	King Khalid Military City near Hafrai Batin	1982	To provide complete health care services to KKMC including 100-bed acute general care hospital and related clinics
Size of personnel: Unknown *Dollar value:* $113 million *Major Saudi Partiicipant:* Saudi Medical Services *NOTE:* Medcom of the U.S. has $7.8 million subcontract to supply hospital training programs.							
10) Riyadh Medical Complex	(Project delayed)	—	MOH contract offer	—	Riyadh	1983 +	1400-bed medical complex
Size of personnel: Unknown *Dollar value:* Unknown *Major Saudi Participants:* — *NOTE:* One of the biggest projects planned in the MOH 1980-85 program—status now uncertain. Plans for the complex were drafted by Rogers, Burgun, Shahine, and Deschler (U.S.) and Saudi Arabian Management Engineering and Research (SAMER) (joint venture Saudi-U.S.).							

SOURCES: Office of Technology Assessment.

Table A-2.—Major Projects and Sources of Investment in Medical Services in Egypt (1971-1981)

Source of funds	Project	Foreign nations involved	Contractors	Product	Year started	Level expenditures	Comments
I. Private sector Equity: Saudi/Egyptian debt: Barclay's Basnco di Roma Misr. Int'l.	Arab Contractor's Hospital		European equipment	Hospital		$17 million	
Equity: Saudi, German, Egyptian debt: Egyptian, Ge-man banks	Misr. International Hospital		European equipment	150-bed hospital		$6.5 million	
Equity: Saudi, Egyptian, American (12.5%), Gulf States	As-Salam International Hospital	1-U.S.	American Medical International	300-bed hospital management	1980	$56 million planned	AMI has withdrawn from management
		2-Korea	Dongsan Construction and Engineering	construction		$80 million actual	
		3-United Kingdom	Widnett & Trollope	quantity surveyor			
Equity: Egyptian, Kuwaiti debt: 70%	Cairo Hospital		European equipment	80-bed hospital		$30 million	
	Squibb Factory	United States		drugs			Only fully private drug factory in Egypt
II. Public/private joint venture							
	Pfizer Company Egypt Swiss Pharma Hoescht Orient El Qahira Co.	United States Switzerland Germany Arab		pharmaceuticals		$20-23 million	Plan as of April, 1979; new factory in Ramadan. Joint venture with Arab Investment Co. for medical industries and medical requirements

Table A-2.—Major Projects and Sources of Investment in Medical Services in Egypt (1971-1981) (continued)

Source of funds	Project	Foreign nations involved	Contractors	Product	Year started	Level expenditures	Comments
III. Public sector							
	Chemical Industries Co.				1978		New plant in Giza
	Memphis Co. Misr Pharmaceutical Co.				1978	$7 million $7-10 million	New factory in Cairo New plant in Abu Zaabal
	El Masr Pharmaceutical Co.	People's Republic of China					Four new plants
	Arab Pharmaceuticals Co.				1978		Tablet and capsule medicines
	Alexandria Drug Co.				1978		Expansion to include veterinary
Japanese Gov't.	Pediatric hospital	Japan	Egyptian engineers medical equipment	240-bed hospital	1979	$30 million grant	Opened 1982, in Cairo
Japanese Gov't.	Medical Education Technology Center	Japan		Closed circuit TV	1982	LE 1 million grant	Equipment additions donation
French Gov't.	Suez Canal University Teaching Hospital	France		teaching hospital	1982	$20 million grant	
	Ismailia Medical School				1977		Opened October 1981 at Suez Canal Univ.
	Assiut University Teaching Hospital			over 1,000-bed teaching hospital			Will open 1983
	Ein Shams University Hospital		over 1,000-bed hospital				Under construction
	Gamul Abdel Nasser Hospital			over 1,000-bed cancer hospital			Under construction
	Cairo area hospitals			hospitals	1979-82		thirteen opened totaling 2,500 beds
Ministry of Health	Medium sized hospitals			100-140 bed hospitals			Sixteen hospitals under construction totaling 4,600 beds

SOURCE: Office of Technology Assessment.

Table A-3.—Medical Services Contracts in Algeria 1979-82

Description of project	Client	Contractor	Location	Value of contract	Year
1. Provision of technical services and medicines for a plant to make antibiotics	Ministry of Health	Indian Drugs and Pharmaceuticals (India)	Medea	Not stated	1979
2. Supply of four mobile laboratories to analyze water and noise pollution	Ministry of Health	Ecopol (France)	—	Not stated	1980
3. Supply of 50 refuse presses and staff training	Ministry of Health	Martex (France)	—	$980,800	1980
4. Supply of 100 incubators for premature babies	Ministry of Health	Vickers Medical (United Kingdom)	—	$264,700	1980
5. Preparation of studies for hospital	Ministry of Health	Uniconsult (Sweden)	Constantine	Not stated	1981
6. Supply of dental equipment	Ministry of Health	Nissno Iwai Co. (Japan)	—	$1 million	1981
7. Construction of three hospitals	Ministry of Health	Maurice Delens & Batipont Int'l. (Belgium)	El-Cheliff	$38.8 million	1982
8. Supply of dental equipment	Ministry of Health	Nissho Iwai Co. (equipment manufacture by Yoshida (Japan))	—	$1 million	1981
9. Pharmaceutical plants feasibility study	Ministry of Health	Chemokomplex (Hungary)	—	$230,000	1982

SOURCE: Office of Technology Assessment.

Table A-4.—Medical Services Contracts in Iraq

Country	Year	Supplier	Description	$ amount
France	1980	Renault Industries	Construction of five hospitals	$116 million
France	1977	Institut Merieux Stodete	Provision of vaccine-producing plant	$24 million
France	1981	No Data	Construct two opthalmological clinics in Baghdad	$40 million
Ireland	1981	Fay International Co.	Construction of hospital sewerage	$0.5 million
Italy	1982	Olsa Construction	Construct vaccine plant	$3 million
Japan	1979	Marunbenicorpstaiset Corp.	Construction of four 400-bed hospitals	$138.5 million
Japan	1981	Marunbeni Corp. and Tisei	Hospital construction	$60 million
South Korea	1980	Hyundia Construction	Construct 2d stage Baghdad's medical city	$338.6 million
Kuwait	1981	No data	Construct 2d stage therapeutic institute	$20 million
Spain	1981	Huarte & Compagnia	Construction of pediatric and maternity hospitals	$175 million
United Kingdom	1982	Shanning International	Medical equipment	$10.8 million
United Kingdom	1979	Architects Co-Partnership	Design of reconstruction and expansion of Baghdad's General Hospital	No data
United States	1980	Med Tech Int	Supply of three 0450 CT scanners, including installation, training and maintenance	$3 million
United States	1977	Roger Butler & Burgan Associates and Whiting Associates International Corp.	2d stage Medical City	$89.6 million approx.
United States	1980	Med Tech Int	Supply of renal dialysis equipment	No data
Yugoslavia	1981	Sutjeska Fabrika	Supply of medical equipment	No data

SOURCE: Office of Technology Assessment.

Table A-5.—AID Health Programs in Egypt (million U.S. $)

Commodity Import Program	1975	24.4[a] 3.0 pending (for Grant 606 FY 83)	Medical Supplies. (Commodities are procured by various Government of Egypt Ministries and organizations as allocated by the Ministry of Investment and International Cooperation. These procurements are periodically announced in the A.I.D. Export Opportunities Bulletin, published by A.I.D.'s Office of Small Business.)
Strengthening Rural Health Delivery	1976	14.9	This grant project is designed to assist the government to identify and validate, through field trials, the principal factors limiting the productivity and outreach of the rural health service, and to devise strategies to reduce or eliminate these factors.
Family Planning	1977	67.6	To strengthen family planning delivery services. The activities include: a) expanded community-based family planning services delivery programs in rural and urban areas; b) integrated health, family planning and social services delivery projects in the Menoufia and Beni Suef Governorates; c) development of a field training site in Alexandria; d) development of a training center at Al Galaa Maternity Hospital; e) a multi-media IE&C campaign; f) innovative activities to test new approaches to FP services delivery. Fiscal year 1983 last year of obligation.
Urban Health Delivery Systems	1979	37.3	This project is designed to improve the delivery of urban health services, particularly maternal-child health (MCH), family planning and nutrition services, in Cairo and Alexandria. The activity emphasizes community involvement, the use of home visitors, the delivery of health services in the neighborhoods where people live, physical improvements to facilities, and cooperation between the health services of Cairo Universities and the Ministry of Health.
Suez Community Health Personnel Training	1980	13.2	This grant assists the GOE in improving health services, particularly primary care, by initiating an integrated medical education and health services program which relates educational investment directly to the health needs of the population. The funds are used to train health personnel to plan, manage and provide preventive and community-based primary health services, including maternal and child health, nutrition, family planning and environmental sanitation.
Control of Child Diarrheal Diseases	1981	26.0	To develop and initiate a national campaign to reduce infant and child mortality due primarily to diarrhea caused by dehydration.
Population/Family Planning II	1983	20.6	To give substantial further stimulus to the several programs centered around the provision of family planning information and services through public and private channels; also to stimulate further understanding of population and family planning issues in a manner which will increase demand for existing and new family planning services and result in significant reduction of the birth rate in the next few years.
Total		261.6	

[a] Includes all but one loan for which the information is not available.

SOURCE: Agency for International Development, Doc. #1215H, Mar. 6, 1984.

Appendix B

Selected Names and Acronyms

AACO	Arab Air Carriers Organization
AID	U.S. Agency for International Development
AKA	Ausfuhrkredit GmbH (FRG)
ARAMCO	Arabian American Oil Company
ARENTO	Arab Republic of Egypt National Telecommunications Organization
ASBU	Arab States Broadcasting Union
ASCO	Arab Satellite Communications Organization
ASRT	Academy of Scientific Research and Technology (Egypt)
ATC	Air Traffic Control
ATU	Arab Telecommunications Union
B/D	barrels per day
BFCE	Banque Francaise de Commerce Exterieur
BMFT	Ministry of Research and Technology (FRG)
BOTB	British Overseas Trade Board
Btu	British thermal units
CANDU	Canadian Deuterium Reactor
CBK	Central Bank of Kuwait
CCIR	Consultative Committee on Radio
CCITT	Consultative Committee on Telephone and Telegraph
CCTV	closed circuit TV
CEA	Commissariat a l'energie atomique (France)
CFCE	French Center of Foreign Trade
CIP	Commodity Import Program (U.S.)
CMEA	Council for Mutual Economic Assistance
COFACE	Compagnie Francaise d'Assurance pour le Commerce Exterieur
COMET	Committee for Middle East Trade (U.K.)
CT	computerized tomographic scanner
DEG	German Development Co.
DISC	Domestic International Sales Corp.
DMZ	Ministry of Economic Cooperation (FRG)
DREE	Directorate of External Economic Relations (France)
EC	European Community
ECG	electrocardiograph
ECGD	Export Credits Guarantee Department (U.K.)
ECWA	United Nations Economic Commission for Western Asia
EMRO	Eastern Mediterranean Regional Office (WHO)
EMS	Emergency Medical Services
EMSS	electromechanical switching systems
EPC	Egyptian Petrochemical Co.
ESA	European Space Agency
ESF	Economic Support Fund
ESS	electronic switching systems
FAA	Federal Aviation Administration (U.S.)
FCPA	Foreign Corrupt Practices Act
FLN	Front de Liberation Nationale (Algeria)
FRG	Federal Republic of Germany
FSC	Foreign Sales Corp.
FTO	Foreign Trade Organization (U.S.S.R.)
GAFI	General Authority for Investment (Egypt)
GATT	General Agreement on Trade and Tariffs
GCC	Gulf Cooperation Council
GDP	gross domestic product
GFCF	gross fixed capital formation
GIC	Gulf Investment Corp.
GKES	State Committee for Foreign Economic Relations (U.S.S.R.)
GNP	gross national product
GOFI	General Organization for Industrialization (Egypt)
GTZ	Deutshe Gesellschaft fur Technische Zusammenarbeit (FRG)
GWe	gigawatt (electric)
HDPE	high-density polyethylene
HEU	highly enriched uranium
IEA	International Energy Agency
IAEA	International Atomic Energy Agency

IATA — International Air Transport Association
IATP — International Air Transport Pool
ICAO — International Civil Aviation Organization
ICB — Industrial Credit Bank (Iran—prerevolution)
IDRO — Industrial Development and Renovation Organization (Iran—prerevolution)
IJPC — Iran-Japan Petrochemical Co.
ILO — International Labor Organization
IMDB — Industrial and Mining Development Bank (Iran—prerevolution)
ITU — International Telecommunication Union
JETRO — Japan External Trade Organization
JICA — Japan International Cooperation Agency
KFH — Kuwait Finance House
KFTCIC — Kuwait Foreign Trading Contracting & Investment Co.
KFW — Kreditarstalt fur Wideraubau (FRG)
KIC — Kuwait Investment Co.
KIIC — Kuwait International Investment Co.
KPC — Kuwait Petroleum Corp.
LDPE — low-density polyethylene
LLDPE — linear low-density polyethylene
LNG — liquefied natural gas
LPG — liquefied petroleum gas
LWR — light water reactor
MEU — medium-enriched uranium
MIO — Military Industries Organization (Iran—prerevolution)
MOH — Ministry of Health
MWe — megawatt (electric)
MWt — megawatt (thermal)
NASA — National Aeronautics and Space Administration
NIOC — National Iranian Oil Co.
NPC — National Petroleum Co. (Iran)
NPT — Treaty for the Nonproliferation of Nuclear Weapons
NSF — National Science Foundation (U.S.)
NTO — National Telecommunications Organization
OAC — Office of Antiboycott Compliance (U.S.)
OAPEC — Organization of Arab Petroleum Exporting Countries
ODA — official development assistance
OECD — Organization for Economic Cooperation and Development
OECF — Overseas Economic Cooperation Fund (Japan)
OPEC — Organization of Petroleum Exporting Countries
OPIC — Overseas Private Investment Corp. (U.S.)
PABX — Private automatic branch exchange
PBO — Planning and Budget Office (Iran—prerevolution)
PCM — pulse code—modulated (telecommunications transmission systems)
PHC — Primary Health Care
PIF — Public Investment Fund (Saudi Arabia)
PTT — Post, Telegraphs and Telecommunications (Ministry)
PVC — polyvinylchloride
Petromin — General Petroleum and Minerals Organization (Saudi Arabia)
R&D — research and development
RCC — Revolutionary Command Council (Iraq)
SABIC — Saudi Arabian Basic Industries Corp.
SAMA — Saudi Arabian Monetary Authority
SANCST — Saudi Arabian National Center for Science and Technology
SASO — Saudi Arabian Standards Organization
SCH — Saudi Consulting House
SCST — State Committee for Science and Technology (U.S.S.R.)
SIDF — Saudi Industrial Development Fund
SITC — Standard Industrial Trade Classification
Sonatrach — Societe Nationale de Transport et de Commercialisation des Hydrocarbures (Algeria)
TDP — Trade Development Program (U.S.)
TFF — Trade Financing Facility (U.S.)
TVT — Televerket (Sweden)
UAE — United Arab Emirates
U.K. — United Kingdom
UN — United Nations

UNCTAD	— United Nations Conference on Trade and Development
UNDP	— United Nations Development Program
UNIDO	— United Nations Industrial Development Organization
USTTI	— United States Telecommunications Training Institute
VHEU	— very highly enriched uranium
WHO	— World Health Organization

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